Illinois Technograph

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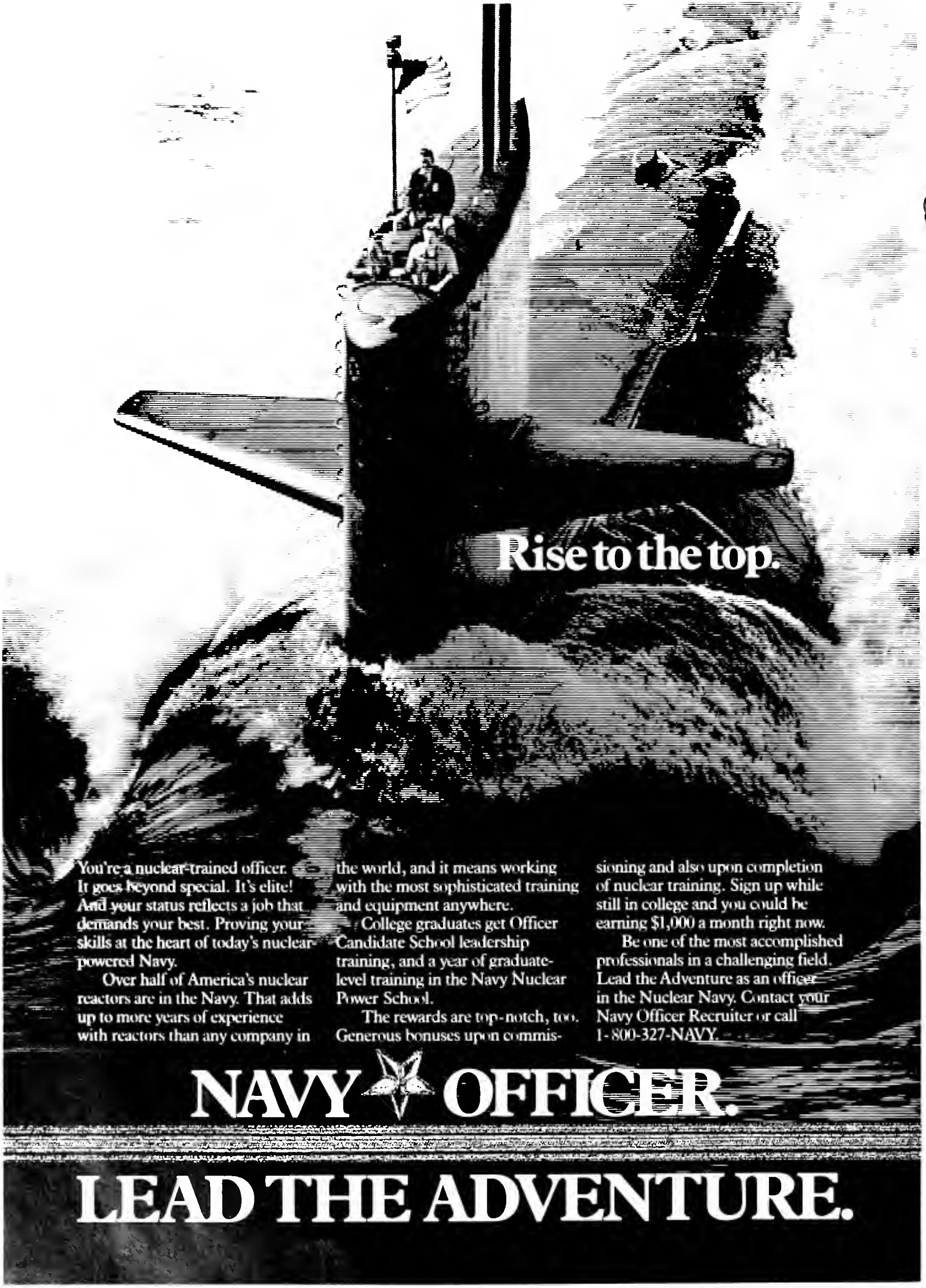
The Merging of Mechanics and Medicine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illinoisTechnograph

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tech teasers

1.Solve the following addition, knowing that **FOUR + 12** equals a perfect square:

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 FIFTY
  FOUR
  FOUR
   TWO
 ---------
 SIXTY
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2. How many squares are on an 8x8 chess board? How about on an n x n chess board?

3. What is the maximum number of knights which can be placed on a chessboard in such a way that no knight attacks the other?

(answers on page 11)

editorial

Serving 35,000 Campuswide

Considering the fact that the distribution boxes for the *Illinois Technograph* are usually empty within a few weeks after the release of each issue, one would imagine that the contents of the magazine have been widely disseminated. Hopefully, the rapid disappearance of the magazine has been linked to an appreciation of the educational and entertainment merit of the publication. While the staff of the *Technograph* attempts to develop subject material of interest to a significant segment of the campus population, the immense size of the University of Illinois gives rise to a spectrum of opinions, and catering to every single one of them would be a task even Atlas would fear. Moreover, as our audience consists of students and faculty, *Technograph* must gear its stories to accommodate both. Thus, our goal is to provide information on engineering topics in a manner that allows for comprehension by those without a substantial technical background, as well as giving educators a student's perspective on subjects they deal with on a daily basis.

In addition, readers should be aware of fields which they may not be intimately connected with. Thus, as both of our feature articles deal with the contributions of engineers to fields that have improved the quality of almost every one of our lives, we encourage you to read the material although it may not be immediately related to your sphere of interest. While classroom work usually does a fine job of teaching mathematical concepts, we often lose sight of the fact that those same static numbers can be translated into dynamic benefits for society, such as improved health care via support technology for the physician or heightened flight safety through instructional software for pilots. Although these articles are not specifically written around such social themes, considering them in this light may help students to realize that tangible accomplishments can result from the manipulation of differential equations.

Despite these noble sentiments, perhaps you would prefer to read about subjects that directly pertain to engineering experiences on the University campus. Should this be the case, we invite you to send to the *Technograph* a list of topics you wish to see developed, whether you be a member of the faculty or student body, engineer or otherwise. Unfortunately, the staff of the *Technograph* cannot claim omniscience as a talent in its possession, so we welcome your ideas. Moreover, in order to receive feedback from as large a portion of the campus as possible, we urge you to pass this issue on to a friend or colleague. As stated previously, since engineering plays such a substantial role in our society in one form or another, the *Technograph* wishes to provide both engineers and those studying other disciplines with an opportunity to learn about technical topics of interest to them.

Scott C. Brun

***Illinois Technograph* invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions are also welcomed. Letters must be signed, but names will be withheld upon request.**

The Merging of Mechanics and Medicine

Dan Powers

Although the physician is the most recognized specialist in health care, support personnel such as the clinical engineer also help provide a safe and efficient medical environment.

Technological advances have enabled hospital staffs to make commonplace what three generations ago would have been inconceivable. However, modern hospitals also have to take responsibility for the safe operation and staggering cost of this technology. Increasingly, engineers in the hospital have become the ones responsible for the consequences of technology.

Engineers may work individually, in departments, for multi-hospital organizations, or on contract from consulting firms. Bioengineers and Biomedical Engineers use classical engineering specialities, such as electrical and mechanical engineering, in order to develop equipment and find ways to artificially model the human body.

Clinical engineers apply engineering knowledge more directly to hospital operations. Equipment is emphasized among a clinical engineer's responsibilities. Clinical engineers use their technical knowledge to purchase or develop products that will satisfy hospital needs and budget restrictions. They are often responsible for inspecting, installing, and testing newly acquired equipment. Clinical engineers also supervise the calibration, maintainance, and repair of hospital equipment.

Clinical engineers work with hospital staffs to establish safety programs. They may also train personnel to properly use new equipment.

These duties all have a common goal. The clinical engineer attempts to reduce the high cost of technology while increasing its safety. In addition to these responsibilities, clinical engineers must be flexible enough to meet needs not yet perceived.

Although clinical engineering, as a separate discipline, has developed mostly over the last three decades, the historical need for technical expertise with machinery can be found in the memoirs of many pioneer physicians.

For example, civil war surgeon, Dr. W. W. Keen describes a battlefield hospital mishap with an etherizer.

"To enable me to see better, the holder of the light lowered it (the candle holder) a bit, as the candles were rather long. Our general idea of any fluid, like water, was that it evaporated upward. *The lamp bearer forgot, or did not know, that ether vapor is heavier than air and falls* downward. *In an instant, everything burst into flames; the etherizer flung the cone to his right and the bottle (we had no tin carrier in those days) to his left. Fortunately the bottle did not break. I instantly seized a towel and covered the patient's face, to prevent his inhaling the flames, and another to protect the wound. . . . A number of us learned several lessons that night."* - Transactions and Studies of the College of Physicians of Philadelphia

Another example of the need for technical knowledge comes from the surgeon, John Collins Warren, professor of surgery at Harvard. He recalls his days in surgery at Massachusetts General Hospital in the 1870's.

"Soon after this came Lister's 'spray', by means of which the air in the immediate vicinity of the wound was rendered antiseptic. This was effected by an atomizer driven by an alcohol lamp which threw a cloud of carbolized vapor over a space several yards in diameter enveloping the patient's wounds and surrounding the attendants." —***To Work in the Vineyard of Surgery***

This new piece of operating room equipment was essential for preventing infection. However, it was useful only when it was properly maintained, as Professor Warren explains:

"I recall the contempt with which this innovation was received by one of the old ward tenders to whom fell the additional duty of keeping the new apparatus in good working order. 'That won't last long,' was his cynical but somewhat prophetic comment. . . . There were many inconveniences and disadvantages, however, in working with the spray technique. It was a source of frequent annoyance that the apparatus would fail to work at the appointed time, and the surgeon's patient was often severely tested by the unavoidable delay."

Health care personnel and automation must work in harmony rather than discord, for while technology assists the physician or nurse in their tasks, machines cannot replace the personal attention that people provide, which aids in the healing process (Photo by Peter Lei).

As an occasional mechanical failure is inevitable when dealing with sophisticated equipment, the clinical engineer must be available to ensure that vital equipment is operating optimally when a physician requires it (Photo by Peter Lei).

As technology proliferated in hospitals, the need for personnel to maintain the equipment increased accordingly. By the 1960's the financial consequences of inefficient health care technology management were being felt. Although scientific advances had made diagnosis and therapy vastly more effective, patient confidence and trust were lower than at the turn of the century. This distrust was partly due to rapidly increasing hospital costs. Hospital administrators recognized the need for equipment experts to reduce costs by extending equipment life, repairing and modifying older equipment, and researching new equipment purchases. By 1959, engineers were being added to hospital staffs.

In the 1970's, citizens began to question the ability of hospitals to operate new technology safely. In the March 1971 issue of *Ladies Home Journal*, 'Ralph Nader's Most Shocking Exposé' appeared, an article by the consumer rights advocate which repeated a prominent surgeon's claim that 1200 Americans were electrocuted the previous year during routine diagnostic and therapeutic procedures. This figure was not documented or ever substantiated, but it resulted in troubled discussion among physicians and hospital administrators, as well as among patients. In response, more clinical engineers were hired to ensure the safety of the patients and the hospital staff.

The most recent development in the role of the clinical engineer has been in the area of hospital design. Hospital buildings have become technologically advanced. Designing for sterility, clean ventilation, adequate lighting, ward layout, and human factors demand the contribution of medical personnel. While clinical engineers do not design or remodel facilities, they may serve as liasons between the traditional medical staff and construction engineers.

Clinical engineeering is one of the youngest branches of engineering. It was formally named only in 1967 during discussions that lead to the founding of the first department of clinical engineering at George Washington University. Hospitals and physicians desire the latest technology to provide patients with the best possible care. As other engineering disciplines develop new technologies and apply them to medicine, clinical engineers will undoubtedly proliferate in the medical field.

Welcome Back!

Welcome back to the start of a new semester! For those of you returning, you can easily recognize these familiar sights. The Engineering Library, centrally located in Engineering Hall, provides a scholarly atmosphere for those long hours of rigorous studying. Good luck!

Engineering Family Album

Mike W. Lind

This sampling of engineering societies gives a taste of the wide variety of activities that can spice up the life of an engineering student.

American Academy of Mechanics (AAM)

Students interested in theoretical and applied mechanics (TAM) might want to check out the monthly AAM meetings. They feature speakers talking about TAM and offer plenty of refreshments. For more information on this group of about 30 people, look for announcements on the AAM bulletin board on the second floor of Talbot Lab.

American Ceramic Society, Student Branch (SBACS)

SBACS is both a social and professional organization. Its meetings feature both representatives from industry and students who discuss their work. For fun, members participate in Tailgreat and a hayride in the fall and a pigroast in the spring. Athletic ceramic engineering students will enjoy the society's volleyball team, the Porcelein Gods, and the society's water polo and ultimate teams. The society is also responsible for publishing the Illini Ceramist Yearbook. Meetings are held in 218 Ceramics on the third Thursday of the month. For more information, contact Kurt Eickmeyer at 344-4933.

American Institute of Aeronautics and Astronautics (AIAA)

The student branch of AIAA keeps aeronautical and astronautical engineering students up-to-date in the field. Monthly meetings feature speakers from the field, while monthly socials allow students to meet and speak with faculty members. This semester, AIAA will make a trip to a McDonnell Douglas plant to view aeronautical engineering in the field. Leave a note in the AIAA mailbox in 102 Transportation for more information.

American Institute of Chemical Engineers (AICHE)

AICHE keeps chemical engineering students informed in a variety of ways. Plant trips and guest speakers at meetings give students contact with the "real" chemical engineering world. For academic help here at the University, the group offers peer advising on courses. Tailgreat and pizza parties give a welcome break from the pressure of classes. For more information, stop by 217 Roger Adams Lab, or call 333-1587 between 11:00 am and 1:00 pm on weekdays.

American Nuclear Society (ANS)

The ANS wants to get more nuclear engineering students involved this year. The society sponsors picnics and intramural teams for socializing, and also holds meetings where representatives from the field of nuclear engineering speak. Contact Glenn Moeller at 356-0207 for more information.

American Society of Agricultural Engineers (ASAE)

Students in agricultural engineering will find that ASAE offers many opportunities for interaction, both with peers and with professors. Meetings on the third Wednesdays of the month feature speakers from the agricultural engineering field. In addition, the society holds student/staff picnics and is planning an exchange with the Purdue chapter. Contact Dale Brockamp in 332-G Agricultural Engineering Sciences Building for more information.

American Society of Civil Engineers (ASCE)

ASCE is the liason between students and professionals in civil engineering. Its field trips to construction sites and monthly meetings give students a feel for the field they can not get in the classroom. The Engineer-in-Training (EIT) refresher course helps students get through the EIT. For fun, the society has happy hours at Murphy's, participates in softball and other sports, and takes part in a concrete canoe race every year. For more information, contact Joe Vespa in 3129 Newmark Civil Engineering Lab.

American Society of Mechanical Engineers (ASME)

This national professional society has a student chapter here on campus. It gives students access to papers from the national chapter. Monthly meetings offer speakers from industry. At Technical Elective Night, professors describe the courses that they teach. The society also sponsors an Engineer-in-Training refresher course and some plant trips. For more information, leave a note in the ASME mailbox in 140 Mechanical Engineering.

Association for Computing Machinery (ACM)

The student branch of this professional organization is a CS-wide society that also features many smaller special interest groups on such topics as artificial intelligence, graphics and electronic music. The society will hold a career day on November 9 to give students a chance to ask questions about pursuing a career in CS. For more information, go to 1204 W. Springfield, room 201 or call 333-5828.

Association of Minority Students in Engineering (AMSIE)

Many opportunities are open to minorities in engineering, and AMSIE helps locate these opportunities. Not only does the society offer plant trips and peer counseling, but it also offers information on writing a good resume and seeking out jobs in a variety of areas in engineering. Meetings are held every two weeks and include a social afterwards. For more information, drop by 302 Engineering Hall or call 333-3558.

Bioengineering Society

The Bioengieering Society is an interdisciplinary society that publishes a newsletter on the bioengineering field. It meets once a month and features lectures from people in the field as well as social events with professors. For more information, contact Sandee Stedwell in 164 Mechanical Engineering, or call 333-1867.

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Simulating the Wild Blue Yonder

Soaring over the plains of Illinois in a flight simulator provides the aviation student with realistic experience. Along for the ride on the wing of the Singer simulator, an instructor of the pilot training department of the Institute of Aviation coaches his student through air flight (Photo by Alyce M. Nogal).

Nancy James and Alyce Nogal

While professional flight simulators, such as the ILLIMAC system, have been in existence for years, recent research in computer programming has resulted in new programs for home computers that successfully mirror the experiences found in professional simulators.

Man's fascination with flight dates back as far as ancient Egypt, where civilization acknowledges myths of men imitating birds. In 1903, mankind reached new frontiers with the accomplishments of the Wright brothers. Today, air travel plays a major role in our everyday lives. While a great deal of the population engages in air travel, only a select few attempt to obtain a piloting license. In addition, many limitations exist on those who are qualified to become licensed pilots. In order to be eligible for licensure for a single engine aircraft, the trainee must be at least seventeen years old, have medical certification, wield excellent English communication skills, and pass the rigorous written, oral, and actual aerial tests. However, prior to taking to the air, the student must implement his training in ground school.

A vital tool used in this aspect of flight training is the airplane simulator. In order to ensure that potential pilots possess sufficient skills prior to going airborne, ground school requires that students spend a mandatory period of three to five hours in extensive simulator training. The pilot training department of the Institute of Aviation of Willard Airport, which happens to be affiliated with the University of Illinois, provides its students with two types of equipment- the Singer link ground simulator and the ILLIMAC system. Through the simulator, the student may practice navigation, instrument reading, approaches, holding patterns, and emergency procedures. Thus, the student may gain proficiency with these valuable manuevers while remaining in the safe embrace of Mother Earth.

While one might assume that flight simulators would require the use of sophisticated technology, their use as an educational tool has not been a recent phenomena. The Singer ground link model has been in use for over fifteen years now. As has been the case with most technology, advances have resulted in a device of even greater utility-the ILLIMAC system. Ever since its inception at the Aviation Research Lab at Willard Airport ten years ago, the project has continued to evolve. When the idea behind the system coalesced, Lynn Staples, project engineer, and Dan Morris, assistant project engineer, decided to develop a low-cost general aviation simulator. As a result of their efforts, the ILLIMAC represents an advanced computer controlled system capable of great accuracy and precision compared to its predecessors.

The ILLIMAC digital avionics resemble those of the most modem aircraft. As a result the student can gain experience with instrumentation that can be considered a near perfect fascimile of the actual thing. During training, the student navigates over an map area that cover the equivalent of two hundred and fifty square miles. As a result of the large geographical area available, a variety of approach schemes may be attempted by the student. In addition, several different airports are programmed into the system. The possibilities include such locales as Peoria, Springfield, and Chicago, to list just a few.

The software which allows for this wide range of travel resulted from the efforts of Computer Science students at the University of Illinois. Following specified developmental parameters, the mic-

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MS-DOS and UNIX United

Companies and researchers will no longer have to decide strictly between UNIX-based and IBM PC compatible machines. A new computer developed by Prime Computer, Inc. in Natick, Massachusetts runs UNIX system software and MS-DOS software simultaneously. UNIX is a multi-user operating system designed by AT &T Bell Laboratories that is popular in the scientific community and MS-DOS is the operating system for IBM PC compatible computers.

Designed around the Intel 80386 microprocessor, the Prime EXL 316 supermicrocomputer supports up to 58 connections to terminals, printers and other computer systems. The computer is capable of executing 3.2 million instructions per second.

Two software packages included with the system allow it to execute software from the two different programming environments. One, called PC-Interface, allows users of IBM PC compatible computers to switch between UNIX applications and MS-DOS applications. The second package allows UNIX-based programs and MS-DOS-based programs to run concurrently.

Despite the variety of programs that the EXL 316 will run, it is only 25 inches tall and can easily fit under a desk. In its fully configured state, it sports 8 megabytes of memory more than a gigabyte of magnetic disk storage.

Picosecond Barrier Broken

With the development of ever-faster electronic switching devices has come the need for ever-shorter electrical pulses to control them. This past summer, IBM scientists created electrical pulses only one-half of a picosecond, or one half-trillionth of a second, long.

The method the researchers used was not a conventional electronic switch. Rather, a short burst of laser light shorted a transmission line etched on a thin piece of silicon, creating an electric pulse. A second burst of laser light, created with the first and time delayed by mirrors, drove an optical sampling switch. This switch measured the electric pulses as they traveled by on the transmission line.

One of the uses for these fast pulses is to study conventional electronic switching devices. The fastest experimental silicon logic devices today switch on and off in about 30 picoseconds, while gallium arsenide devices switch in about 10 picoseconds. The one-half picosecond electrical pulses will help study these leading edge logic devices in greater detail.

Coal's Comeback?

Mention a coal-powered locomotive, and many people picture a filthy man shoveling coal into a smoke-belching iron horse. That era of the the steam engine train may be gone, but coal may once again power locomotives.

Leon Green Jr., of Energy Conversion Alternatives, Ltd. in Washington D.C., has suggested that coal water slurries could power turbine engines in future locomotives.

Since coal water slurries are liquids, they can be stored in conventional fuel tanks. Even though the slurries are composed of coal, they avoid many of the problems associated with solid coal. Current coal water slurries are made with low-sulfur coal and are in compliance with sulfur dioxide emission regulations, according to Green. In addition, as coal slurries are de-ashed when prepared, Green says he believes that they can meet mobile-source particulate emission requirements with few problems.

The only element which must be further developed is adequate heater or combustor technology, according to Green. One heater which could meet the requirements would be a pressurized, combustion-stirred fluidized heat exchanger. This combustor consists of a lower chamber and an upper chamber, each pressurized to 10 atmospheres. Fuel is partially burned in the lower chamber and then travels to the upper chamber. There, the hot gases fluidize a bed of ceramic beads. The beads circulate in the chamber, where they grind char and any ash into easily-burned particles. The hot beads then transfer their energy to a heat exchanger. Hot air from the exchanger would power a closed cycle gas turbine to produce electricity to drive the locomotive.

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Engineering Council

As the umbrella organization of all of the engineering societies, Engineering Council offers more opportunities than can possibly be listed here. The Council not only offers a voice for students through the Dean's Student Advisory Committee (DSAC),but it also offers many programs and activities for students.

Engineering Open House, which most societies participate in, is organized by the Council. Students can join the Engineering Speakers Bureau or help with the Student Introduction to Engineering to educate high school students about the college. If organizing conferences is your game, then you might want to help out with the Leadership Conference or Graduate Conference. Freshmen need not feel left out, as they can be part of the Engineering Freshman Council. There are also many social opportunities for students, including organizing the Knights of St. Pat ball after Engineering Open House, as well as bowling and volleyball tournaments.

If you are interested in these or any other of the numerous activities of Engineering Council, drop by 300 Engineering Hall or call 333-3558.

Illinois Society of General Engineers (ISGE)

ISGE tries to inform engineering students that general engineering is not just a major to pursue until a student discovers his favorite field. To accomplish this goal, the society features meetings where graduate students and professionals speak about

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roprocessor uses Assembly language. The inclusion of this language as the base of the system facilitates the compilation of data on an IBM computer. As a consequence, detailed records may be kept for future reference on each student who practices on the simulator . Research currently extends into student data bases, where each student would have his own disk of simulator training.

For those of us who would rather not expose ourselves to the rigors of formal flight training, there exists an alternative manner to experience flight on an amateur level. A software program, Flight Simulator II, is available on floppy disk for home computers from SubLOGIC in Champaign. The program models a Cessna 184, displaying a cockpit view of the airspace. Actual manuever execution is accomplished through user input via the keyboard. By using the program, aspiring aviators may attempt the more traditional forms of flight, or they may try their luck at death-defying feats ranging from landing on an aircraft carrier to navigating under the Golden Gate Bridge.

In order to program scenery for the diskettes, SubLOGIC engineers actually take to the skies. Some have even researched projects from the seat of an acrobatic plane. As high level programming languages generally could not effectively create the high-speed graphic animation highlighted in this simulation, an alternative type of programming format needed to be sought out. The search for a solution resulted in the creation of Real-Time Animation Language (RTAL), a language that has become the basis for other three-dimensional personal computer animation projects.

Flight Simulator II offers an excellent introduction to the type of style employed in the actual simulators. Obviously, on both the personal and professional fronts, engineers have devoted considerable amounts of their time in developing support technology that allows for aviation training without the risks inherent in journeying into the wild blue yonder.

(continued from page 7)

their work. The society also sponsors picnics, and bowling outings with faculty members. For more information, contact the General Engineering Department Office at 333-2730.

Illinois Technograph

As an interdisciplinary magazine, the *Technograph* is dedicated to bringing engineering students the latest information about technology. The *Technograph* has positions for students with writing skills, interest in photography, or business acumen. If you would like to become a published author or photographer, call Scott Brun at 384-2040.

Institute of Electrical and Electronic Engineers (IEEE)

With so many different areas in electrical engineering, how does an electrical engineer decide which one to pursue? IEEE can help with this decision. Its general meetings and career fairs offer representatives from different companies who talk about the various areas of electrical and electronic engineering. IEEE's main event this year will be the Student Professional Awareness Conference (SPAC). Professional and academic representatives will discuss undergraduate engineering issues. This semester a movie night gave IEEE members a break from the drudgery of homework. For more information, drop by the IEEE office in 247 Electrical Engineering.

Institute of Industrial Engineers (IIE)

The student chapter of this professional organization helps promote the industrial engineering profession. It sponsors industry speakers, including engineering alumni and co-operative education students. Plant trips, like last year's to the Chicago Tribune and Abbott Laboratories, will be highlights of this year. Of course, the society offers social events such as picnics and bowling nights. For more information, contact Nils Albert at 384-0074.

Phi Sigma Rho

Until now the University has not had a sorority specifically for women in engineering. Phi Sigma Rho is being organized this year, and is looking for women in technical fields to join. If you are interested in this social and professional sorority, call Pam Warmack at 384-0431.

Sigma Phi Delta

This social and professional engineering fraternity gives engineers a chance to help build a homecoming float, sponsor a triathalon, and participate in other activities. It also sponsors professional programs with College deans and professors, and EOH projects. For more information, stop by the house at 302 E. Gregory St., Champaign, or call the rush chairman, Larry Melvin, at 337-7511.

Society for Cooperative Engineers

Tired of classes? Want some "real world" experience? If so, co-operative education may be for you. The Society for Cooperative Engineers helps promote the University's co-op program with job fairs and brings co-op students together for picnics, volleyball games and happy hours. For more information, contact the Co-op Office in 213 Engineering Hall, or call 244-0906.

Society of Automotive Engineers (SAE)

This semester, SAE co-sponsored the National Collegiate Driving Championship with Dodge and Goodyear. This event gave students a chance to pit their driving skills against a pylon course. The society is also reconstructing a 1976 Datsun 280Z. The group plans to travel to Detroit this year for the annual SAE convention. For more information, leave a note in the SAE mailbox in 140 Mechanical Engineering, or stop by the SAE glass display case outside of 101 Mechanical Engineering.

Society of Women Engineers (SWE)

This professional engineering society, open to both men and women, exists to support women engineers. The University's student branch recruits women engineers to speak about engineering careers and the resources available to women engineers. This semester the society sponsored a technical career night. The society plans to go Christmas caroling at a local nursing home and sponsor a bowling tournament. Drop by 302 Engineering Hall or call 333-3558 if you want more information or would like to join.

SYNTON

Have you ever dreamed of making friends in far away places? If you have, SYNTON, the ametuer radio society, may be for you. Members of SYNTON are usually interested in building the electronic equipment necessary for global communications, or simply enjoy using the equipment to talk to people all over the world. Licensed members can use the society's equipment in its station. The society also offers novice licensing classes for newcomers. For more information, call the station at 244-5798 or call Joe Sluz at 351-8885.

University of Illinois Metallurgical Society (UIMS)

UIMS meetings offer speakers from the Department of Metallurgy and Mining Engineering and other related depart-

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Spreading the Word

Loretta L. Jones, associate director of the general chemistry program at the University, was selected this summer to help spread her knowledge of video instruction methods. As part of International Business Machines' Consulting Scholar Program, she will visit other campuses across the country for one year to discuss the design of interactive videodisc lessons.

Jones was one of five educators selected for the program. The educators were selected for their expertise in an area of computer-based instruction. IBM will pay all of the program's expenses.

Jones is no newcomer to the video instruction field. She has 13 years of experience producing video-based chemistry lessons and has also helped design lessons in physics, biology and mathematics.

Tutoring for All

You may be at the end of your rope in that one class. It may be physics, circuit analysis or any of many other classes that can sneak up behind you and surprise you. Don't panic! Instead, call Tau Beta Pi for help.

Tau Beta Pi engineering honor society offers free tutoring for a variety of engineering classes. Whether it is Physics 106 or a 300 level mechanical engineering elective, a Tau Beta Pi member can probably help. To take advantage of this service, visit the Tau Beta Pi office in 302 Engineering Hall, or call 333-3558. Tau Beta Pi will give you the name of a tutor who has taken the class and offered to help others make it through. Just remember that the sooner you call, the better off you will be!

The Beginning of *ChAPTER One*

Chemical engineering students now have their own national publication. Called *ChAPTER One*, the biannual magazine is published by the American Institute of Chemical Engineers (AIChE) in New York.

The magazine, which debuted September 15, features articles on career development and new technologies. Outstanding students and professionals are also profiled in every issue. For students seeking chemical engineering opportunities, a regular department lists scholarship and professional contests.

Issues of *ChAPTER One* are mailed directly to undergraduate student members of AIChE. Other students may subscribe at a rate of $10 per year. For more information, contact the Communications Department, AIChE, 345 E. 47th St., New York, NY 10017.

Notes Needed

One of the purposes of the Tech Notes department is to publicize events sponsored by engineering societies. In order for us to announce your society's event, we need to know about it! Below are the deadlines for this years issues of *Technograph*:

Publication Date/Note Due Date

Dec. 4/Friday, Oct. 30

Feb. 12/Friday, Nov. 27

April 15/Friday, March 4

You may submit announcements in Mike Lind's mailbox in 302 Engineering Hall, or call him at 384-2040.

Tech Teaser Answers

1.	48439	also	49438
	4612		4612
	4612		4612
	376		376
	----------		----------
	58039		59038

(Teaser 1 was taken from the December, 1961 issue of American Mathematical Monthly)

2. There are 204 squares on an 8x8 chessboard. On any n x n chess board, there are (n+1−j) squared number of j x j squares. Thus the total number of squares equals (sum j=1 to n) of (n+1−j)squared, which equals n(n+1)(2n+1)/6. (Teaser 2 was taken from the January, 1964 issue of American Mathematical Monthly.)

3. The answer is 32. Note that a knight may move only from a black to a white space and vice-versa. Since a knight can tour the chessboard exactly once, and there are 32 black spaces, 32 knights can be on the board simultaneously. (Teaser 3 was taken from the February, 1964 issue of American Mathematical Monthly.)

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ments. This year, in addition to plant trips, the society plans on establishing a mentor group of juniors and seniors to offer guidance to freshmen in the department. Also, a new co-op student panel will provide students with information about co-operative education. Phone the society's office at 333-0789 if you have questions.

Triangle Fraternity

This social fraternity is for engineers, architects and science majors. This year it plans to sponsor a homecoming float, a barn dance, sports teams and other events. For more information, contact the informal rush chairperson, Gary Walther, at 384-9668, or stop by the house at 112 E. Daniel St., Champaign.

Professor Bruce Wheeler of the Electrical and Computer Engineering Department is well known among electrical and computer engineers for his amiable lecturing style. After teaching EE 244, Electrical Engineering Laboratory I, for several semesters, he is currently teaching EE 310, Digital Signals and Systems. "I like teaching; I wouldn't be here otherwise," he says. Wheeler also works with students as the Bioengineering Society advisor. He received the Engineering College's Pierce award in 1987 for facilitating faculty-student interaction.

Wheeler's research has been in the areas of bioengineering and solid state biosensors. To monitor the activity of small groups of neural cells, he developed a 32-channel electrode array with 200-micron electrode separation. He has been studying drugs such as penicillin and picrotoxin which cause epileptic-like activity in laboratory rat brain tissue. Wheeler says he believes that a model which mimics epilepsy may eventually help other researchers develop treatments for the disease.

In addition to studying small groups of neural cells, Wheeler has been analyzing and classifying the electrical signals of individual brain cells. He has been developing equipment to record the neural signals, and real-time algorithms to analyze them.

Neural systems are being vigorously studied because of possible applications in artificial intelligence and computer architecture, Wheeler says. Aspects of neural networks have already been implemented in parallel processor computer architecture designs, according to Wheeler. His research and the equipment he has developed may facilitate further research in this area.

Professor Wheeler was an undergraduate student at the Massachussetts Institute of Technology where he graduated with joint degrees in science and history. He earned masters and PhD degrees at Cornell University and came to the University of Illinois in 1980.

David Song

Timothy F. Weiss, Associate Professor of English, wants to instill in his students the importance of communication, not only in their future job duties, but in all aspects of their lives. His avenue of influence for this goal is his class, Business and Technical Writing 252, Technical Communication.

Weiss' globetrotting background begins with undergraduate studies at the University of Colorado, where he picked up a B.A. in English in 1971. He received his Masters of English from the University of Wisconsin in 1974, and then had a two-year stint in the Peace Corps during which he taught English writing and literature at Cuttington University in Liberia. The time he spent in Africa convinced Weiss that he liked warm weather better than the cold extremes of Colorado and Wisconsin. This led him to the University of New Mexico, where he earned his Doctorate of English in 1981. Apparently, New Mexico was not hot and dry enough for Weiss, because he headed to Saudi Arabia to teach at a Saudi Arabian university for one year. After teaching for brief periods at the University of Kansas and Iowa State University, Weiss joined the faculty at the University of Illinois in 1985.

In his short time here, Weiss has instituted many changes in BTW 252. The class was originally titled Technical Writing, but was changed to Technical Communication to include a broader range of media. The number of engineering students in the class has also increased. Weiss welcomes the increasing number of engineers, and stresses that it is especially important for them to adopt an international perspective on communication, since most technical literature is published in English. He has also begun to use word processors extensively in the class, and hopes to add a graphics package to the system in the near future. Those interested in taking BTW 252 should act quickly if they want Weiss as their professor. Weiss is in the running for a Fulbright Scholarship which would send him back to Africa and warmer skies for the 1988-1989 acedemic year.

W.Dan Leonard

"HOW I MADE $18,000 FOR COLLEGE BY WORKING WEEKENDS."

When my friends and I graduated from high school, we all took part-time jobs to pay for college.

They ended up in car washes and hamburger joints, putting in long hours for little pay.

Not me. My job takes just one weekend a month and two weeks a year. Yet, I'm earning $18,000 for college.

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So, since I'm helping them do such an important job, they're helping me make it through school.

As soon as I finished Advanced Training, the Guard gave me a cash bonus of $2,000. Then, under the New GI Bill, I'm getting another $5,000 for tuition and books.

Not to mention my monthly Army Guard paychecks. They'll add up to more than $11,000 over the six years I'm in the Guard.

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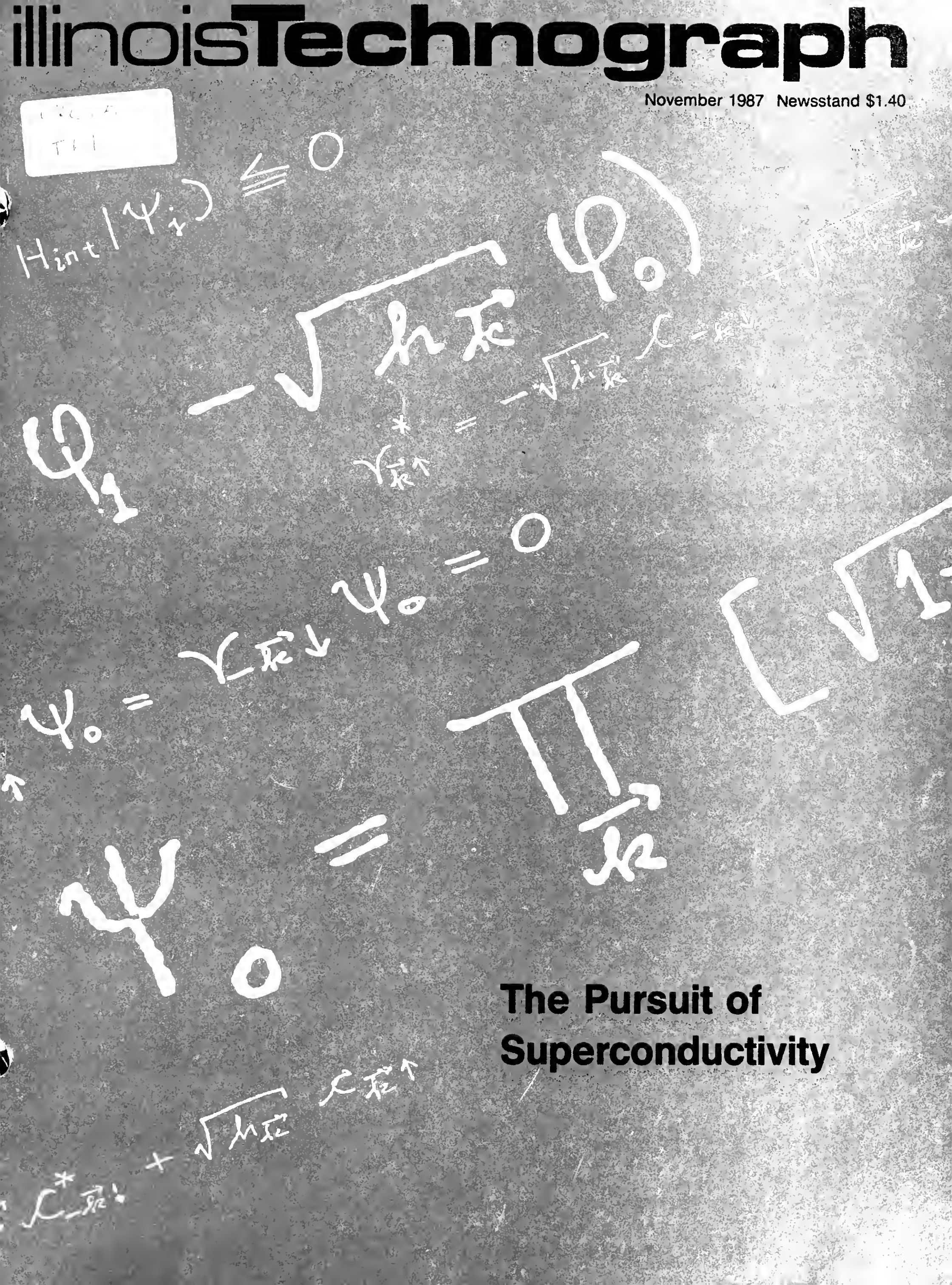

The Pursuit of Superconductivity

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editorial

Mother Nature-Professor of Engineering

In order to function effectively, the engineer should be quite familiar with the disciplines of mathematics and science. It is necessary, however, to define exactly which fields of knowledge, among the many loosely labelled as "science", are of value to the engineer in his or her annointed task. At the University of Illinois, the physical sciences are traditionally defined as physics and chemistry. However, since the engineer must deal with matter and energy in nature, one might be curious as to why the engineer's background in the physical sciences is not extended to the domain of natural science by the addition of biology to his educational program. After all, the College of Liberal Arts and Sciences has found a place for biology, as its program requires at least one biology course, even for non-science majors.

The traditional argument against the inclusion of biology in a standard engineering curriculum revolves around the fact that the additional hours of study this change would require could overburden the student. Considering the challenging and extensive training our students receive at the University, this claim wields considerable merit. However, perhaps biology could be fit into a schedule in the place of one or more technical electives, such as the upper-level classes that provide the student with specific "up to date" information, which often suffers from obsolescence soon after its presentation or which may be assimilated with greater ease through on-the-job training. This loss of "icing on the cake" would appear to be an adequate sacrifice for an introduction to another basic science that can serve as a substantial foundation for the further accumulation of knowledge.

Nevertheless, one may wonder whether the additional knowledge gained from the study of biology would be of any practical use to the engineer. While this approach certainly will not immediately solve all current engineering enigmas, an appreciation of biology may aid the engineer by encouraging him to seek solutions to engineering problems through the observation of nature. Indeed, centuries ago, initial interest in optics was stimulated by the observation that concave water droplets on leaves refract light in such a manner as to produce magnification. Flora and fauna provide excellent examples of useful structures, systems, and processes which the engineer may be able to adapt for his special purposes. Our own bones are fine examples of civil engineering, as their internal structural arrangement provide a relatively low density material that can withstand greater tensile, compressive, and shear stresses per unit weight than granite or concrete. The joint arrangement in the appendages of the grasshopper was suggested as a basis for the landing gear of the British Harrier jet. Researchers in the field of computer science might find the cell a fascinating playground, as the DNA present in the nucleus acts as a premier example of compact data storage, providing 45 million storage positions, each capable of taking on one of four values, held in a roughly spherical volume with a radius on the order of the width of a human hair. In addition, through the process of evolution, "nature's designs" have been field-tested and optimized over millions of years to allow the organism to efficiently interact with its environment.

In order to expose engineers to this wide variety of natural phenomena which could serve as a springboard to further creative thought, perhaps a specialized biology sequence could be designed which would emphasize concepts of utility to the engineer. Certain topics of lesser interest, such as plant biology, could be removed from this technical survey of the life sciences (although the method by which trees transport water from roots to leaves, generating 300 atmospheres of pressure in the process, calls into play considerable hydraulics). However, since the development of such a class would demand considerable time and toil and may not be feasible in the immediate future, perhaps professors teaching physical science courses could devote more attention to biological phenomena pertinent to their subject matter. The extensive coverage given to the eye by the physics department during a unit on optics offers a fine example of this spirit, and the hydrodynamics of capillary action, the dynamics of limb movement, the thermodynamics of metabolism, and the RC circuit properties of neurons offer further material that can be developed in a similar vein. Such an exposure to biology could act as a catalyst for further interest and study of the subject by students (and staff), as engineers discover just how much Mother Nature can offer to their chosen profession.

Scott C. Brun

Illinois Technograph **invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions are also welcomed. Letters must be signed, but names will be withheld upon request.**

technovations

Inside-Out Delivery

Doctors in the future may explore the body's ducts using catheters that actually turn themselves inside out as they travel through the body. Daniel R. Shook, a biomedical engineer at the biomedical engineering and instrumentation branch of the National Institutes of Health in Bethesda, Maryland, described the everting catheter in a recent American Society of Mechanical Engineers journal.

Essentially, the everting catheter is a flexible catheter inside of a rigid catheter. The rigid outside catheter is inserted into the body similar to a conventional catheter. The doctor then pushes the flexible inner catheter out, causing it to unfold and turn inside-out along the walls of the duct.

Because of the everting catheter's flexible design, it can follow extremely complicated vessels, yet there is little friction against duct walls, according to Shook. In addition, only the tip, rather than all of the catheter, moves through the vessels.

As with conventional catheters, everting catheters can deliver drugs and instruments to many different parts of the body. An everting catheter, however, can negotiate extremely twisted vessels, such as those in the brain. According to Shook, the catheter can easily navigate through these vessels and deliver drugs to tumors without delivering the drugs to surrounding tissues.

Two companies already hold licenses to manufacture the catheter, but they are not currently marketing it. The main problem with the everting catheter is that a doctor cannot easily control the direction that the catheter takes once it reaches a branch in a vessel. Shook stated that further development was needed to solve this problem.

CD River Data

During the past few years, compact disk read only memories (CD-ROMs) have promised to replace many of the dusty reference volumes used by engineers and scientists. One company that has done much work in this area is U S WEST Knowledge Engineering, Inc. of Denver, CO. It recently introduced two products that put a century of river flow data on the portable disks.

The first product, introduced last spring, is called Hydrodata and compiles more than 100 years of water quality and river flow data. The second product, Hydropeak, was introduced in September and contains flood flow information for the entire United States.

Normally, hydrologists, civil engineers, and planners must access this information from large mainframe computers. With the Hydrodata and Hydropeak CD-ROMs, the data is accessible on their personal computers.

CD-ROMs are essentially identical to standard audio compact disks, except the data encoded on them represents text or graphics, rather than music.

Because of their large capacity, much more information can be included on the CD-ROMs than in conventional formats. The results of some common calculations, such as standard deviations and other overall figures, have also been included on the CD-ROMs to better utilize their capabilities.

Each product comes with a software package that allows the planners not only to access and print the data, but also to transfer the data to other programs, such as spreadsheets and word processors. Professionals can thus not only retrieve the data, but also quickly put it to use.

Light Meets Electricity

Communications technology is rapidly moving toward fiber optics because of the extreme speed with which they carry data. One problem this transition presents is that of converting the light pulses carried by optical fibers to electrical pulses used by computers. International Business Machines Corporation recently announced the development of an experimental computer chip to convert light pulses back to electrical pulses.

The new chip is made of gallium arsenide (GaAs) rather than conventional silicon. Not only can a GaAs chip convert signals faster than its silicon equivalent, it also does it more efficiently.

The primary problem with creating fast photodetectors is the interference conventional electronic circuitry causes. Long wires from photodetectors to their electronic amplifiers make the detectors very susceptible to noise. To reduce this noise, the photodetectors must be built on chips alongside other electronics.

IBM scientists chose GaAs as the base material for the new chips, but encountered new problems because of the choice. The high-temperature annealing process used to create transistors changed the photodetector's characteristics. They found that adding small quantities of certain other materials ("doping") allowed the detector to maintain its characteristics during high-temperature processes.

Overall, the IBM scientists believe that the new chips are as much as two times faster than any previous designs.

University Scientists Supervise Superconductivity Research

Scott M. Heydinger

Since last spring's discoveries in superconductivity, the University of Illinois has been pursuing superconductor research more actively than ever.

The University of Illinois, Urbana-Champaign has been very active in superconductor research since the recent discoveries of higher temperature superconducting materials. Earlier this year, it was found that certain ceramics could be made to lose their resistance to the flow of electricity, or superconduct, at relatively high temperatures. These discoveries have sparked intense research around the world.

In February, Myron Salamon, professor of physics and assistant director of the Materials Research Laboratory, began trying to obtain funds. He applied for funding from the National Science Foundation to allow University scientists to conduct new studies in superconductivity. Other funding was obtained from the Department of Energy and the Department of Defense. Faculty members were also redirected to superconductor research. "It's still a struggle," Salamon explains, because more University scientists are interested in the field than can be supported.

Currently, the University is collaborating with companies such as IBM and DuPont. Also, Salamon says he looks forward to the University joining the proposed Illinois Superconducting Institute. This organization would tie together university and industrial knowledge within the state.

Initially, graduate students were asked to put their thesis work on hold and begin studying the new materials. The students were enthusiastic about studying the new field, Salamon said. At present, the list of professors and students is still growing.

Professor Emeritus John Bardeen is one University researcher who has been previously involved in superconductivity research. Bardeen shared the 1972 Nobel Prize in Physics for a theory explaining how conventional superconductors work. Last May, he discussed possible ways of understanding the new superconducting phenomena at a conference in Berkeley, CA.

Donald Ginsberg, professor of physics and a co-leader of the thrust group for high temperature superconductivity research, has been experimenting on superconductivity since he came to the University in 1959. His interest began as a graduate student in 1956. Ginsberg also wrote the article on superconductivity in the 1974 edition of *Encyclopedia Britannica*.

Bardeen says he is impressed with the rapid pace of discovery. He also says he believes that the University is now well equipped for the work. He admits that the University does not have the largest superconductivity research center. However, he says the University has been at the forefront of the field since the program began. Ginsberg agrees: "The total effort here is one of the most extensive in this area at any university."

University researchers have been working to achieve a better understanding of the science of superconductivity. By controlling and optimizing the parameters involved in the production of superconducting compounds, researchers can obtain valuable information about the electronic interactions which are responsible for supercondutivity. Eventually, it is hoped that this understanding will aid the search for even higher temperature superconductors.

The University produces almost all of the superconducting samples it needs for research. Mark Reeves, graduate student in physics, explained how superconducting pellets are made at the Materials Research Laboratory. Yttrium, barium, and copper oxide powders are mixed together. The powder compound is then pressed into pellets with 2000 pounds of force applied over the quarter inch-diameter sample. The pellets are then sintered, or heated, in an oxygen atmosphere. This hardens the sample and allows it to absorb oxygen, the key to producing a good sample. The resulting compounds are then characterized and distributed to other groups on campus for experiments.

University researchers are working to produce larger single crystal samples. Since the magnetic properties of superconductors depends on the orientation of crystals within the sample, it is better to have a sample that consists of one large crystal rather than many smaller, randomly arranged crystals. Joe Rice, graduate student in physics, has grown thin single crystals which are about 2 mm square. Making a sample large enough for certain

Mark Reeves, graduate student in physics, patiently fills a dewar flask with liquid helium in order to carry out low-temperature calorimetry experiments on superconducting materials (Photo by Dan Powers).

experiments is a challenge, though. "That's the trick," says Bardeen. P. Han and David Payne, professors of ceramic engineering, are also trying to grow bigger and thicker single crystals.

Payne is also head of the materials science and engineering department, which was recently formed by combining the ceramics and metallurgy departments. His own work involves rapidly solidifying a superconducting compound and producing an amorphous solid. The solid is then melted and slowly solidified, enabling him and his students to find out how a superconductor achieves its structure.

Another experiment involves taking measurements with SQUID, the superconducting quantum interference device. Brian Pazol, graduate student in physics, considers it a sensitive voltmeter. Since the concentrated research program began earlier in the year, those researchers involved in high critical temperature (or high T_c) research have managed to keep the machine booked solid, said Sue Inderhees, graduate student in physics.

One of the major pure science aspects of superconductivity being studied at the University is the heat capacity of superconducting materials. Reeves, who is studying this property, says that results of this research will help theorists gain a better understanding of the mechanisms behind superconductivity.

To carry out his experiment, Reeves uses a sophisticated calorimeter which was designed and fabricated at the University. The instrument is not very common, making the University one of the few places able to conduct this type of study, Reeves said.

The device consists of two insulating dewar flasks, one inside the other. The outer one contains liquid nitrogen to cool the inner dewar flask, which is filled with liquid helium or liquid nitrogen. Inside the inner flask is an evacuated probe that contains the superconducting sample. Measurements are taken under computer control. The volume inside the probe, where the actual measurements are taken, is gradually heated by a resistor. By determining the amount of energy needed to raise the temperature of the sample one degree, its heat capacity can be found.

The results of this experiment included an unexpected phenomenon below 10 K. Ginsberg presented the findings at the March meeting of the American Physical Society in New York.

Relva C. Buchanan, professor of ceramic engineering, is producing thin films of superconducting compounds. A solution of organometallic carboxylates is concentrated by heating. The solution is then spun onto a substrate, where it forms a solid film about one micron thick upon heating. He says it is important to look into this matter because, "this is the only form in which the carrying of higher density currents has been achieved to date." He says he also intends to look into improved methods of producing pellets and possibly wires.

Other researchers at the University are attempting to create better compounds by studying the absorption of oxygen during the sintering process. About ten theoretical physicists are devoting substantial amounts of their time to the field. George Kordas, associate professor of ceramic engineering, has recently developed a process for developing superconducting compounds at 1100° F instead of 1750° F. Numerous other aspects of superconductivity are being investigated; undoubtedly the list of achievements in this field will continue to grow.

Bardeen says he sees a bright future for the field. He predicts that as a result of all the data now being generated, "things will begin to shake down in the next few months," and the correct theoretical approach could be chosen from among the many theories that currently exist. Considering the amount of research taking place in Urbana-Champaign, the next big superconducting discovery may well come from the laboratories of the University.

Mike Pavlovic

tech visions

A Centripetal Celebration

Engineers can have a field day computing the amount of centripetal force required to navigate the curves on this twenty-four foot long skateboard ramp built by Urbana resident Randy Gawlik. The product of a week's worth of intensive labor, the ramp is extensively used by daring high school and college students.

A Liberal Look at Engineering

Mary J. Winters

By taking advantage of a program offered by the Colleges of Engineering and LAS, some students are gaining the benefits of a broader education as well as greater desirability by employers in their chosen engineering field.

"All engineers ever think about is calculus and slide rules." "An engineer can't study literature; he's too busy solving equations." "Everyone knows that engineers are geniuses who wear glasses and go around quoting Einstein and Copernicus."

Generalizations like this are quoted and believed by many people. The thought that an engineer can know anything besides engineering seems to surprise people. Of course, they believe that engineers are people, too, but they think that studying for an engineering degree leaves little time for anything else.

The engineering curriculum at the University of Illinois, Urbana-Champaign does leave little room for electives. Although eighteen hours of social science and humanities courses are required, other technical electives can easily fill up a four-year schedule. However, there is a way for engineering students to get a more rounded education, and more and more students are taking advantage of this opportunity.

For over twenty years, there has been a program at the University which allows students to receive degrees from the College of Liberal Arts and Sciences and the College of Engineering in five years. This program "permits a student to earn a Bachelor of Science degree in a field of engineering from the College of Engineering and a Bachelor of Arts or a Bachelor of Science degree from the College of Liberal Arts and Sciences". (*1985-87 Undergraduate Programs*)

Originally, the program was intended just for students with a wide range of interests. Twenty years ago, there was not as much emphasis placed on careers as there is today. Students who wanted to take some extra courses were able to do so, and the program let them earn an extra degree at the same time.

According to the Undergraduate Programs guide, the five-year program allows students to prepare for interdisciplinary careers. It also enables students to develop a well-rounded cultural education in addition to their engineering specialty. "It gives students an opportunity to get some breadth in their education that is formally recognized," says Harry Wenzel, assistant dean of engineering. Bruce Hinely, assistant dean in Liberal Arts and Sciences, agrees with this assessment of the program's primary thrust. "In my opinion, the main purpose is to combine the scientific and technical knowledge which the engineering curriculum provides with the broader, more rounded education that the LAS curriculum provides."

This does not mean, however, that students can take shortcuts in either college when they decide to study for two degrees. All admission and graduation requirements for both colleges must be met.

Wenzel and Hinely agree that many students enter the program after their freshman year. Wenzel says that many transfer students who already have a significant number of credit hours in either or both colleges enter the program when they transfer. Dean Hinely estimates that only about half of the students who enter the program do so as freshmen.

Students enter the program for many reasons. Some engineers simply enjoy taking liberal arts classes. Others have a more specific purpose. Hinely says that several students are studying computer engineering and psychology with the intention of applying their knowledge to artificial intelligence. "By selecting an appropriate liberal arts and sciences major in combination with the desired engineering curriculum, it is possible for students to qualify for new and unique careers in industry, business or government". (*1985-87 Undergraduate Programs*)

There are currently 138 students registered in the program. According to Dean Hinely, enrollment has grown considerably in the last three or four years. About five years ago there was only a handful of students in the program, he says.

Students in the program usually spend their first year in the College of Engineering. The following two years are spent in LAS, and the final two years are spent in the College of Engineering. This does not mean that a student can only take engineering courses while in the College of Engineering and liberal arts classes in LAS. Usually, a student mixes his engineering and LAS courses. The transfers do allow each college to hold the student's records for a time.

When a student decides to enter the program, he obtains a five-year program form. Because the program assumes that a student will take courses which can fulfill requirements in both colleges, the student

must carefully choose his classes. He then organizes his classes and completes the form. However, this proposed schedule does not need to be followed strictly. It is possible to switch courses between semesters or to take courses during the summer.

After the student has filled out the form, he must see his engineering advisor, who reviews the form and makes sure all the required engineering courses are listed. After the engineering advisor signs the form, the student takes the form to his LAS advisor for the same reason. Then the student brings the form to the engineering college office and a copy to the LAS office. After that, a student only needs to complete the five years of classes, which may require taking eighteen or nineteen hours of classes in a semester.

Apparently, most students who enter the program believe the work is worthwhile. "I haven't seen that many (students) drop out," Wenzel says. However some students do drop out because they decide that a secondary degree would not be as beneficial as originally supposed or that the program does not satisfy their specific needs. For example, some students decide to get their Bachelor's degree in one major and then attend graduate school to receive a Master's in another area. Many students are interested in receiving joint degrees in engineering and business. However, there is currently no joint program between the College of Engineering and the College of Commerce and Business Administration.

There are many ways to combine engineering and LAS degrees. As previously mentioned, computer engineering and psychology is one popular choice. Some others are: computer engineering and rhetoric, computer science in engineering and a foreign language, and general engineering and English. It would even be possible for a student to study computer engineering and computer science/math.

Some students in the program believe that the program will help their careers. Engineers with a more liberal education are desired by employers. "It's a good thing to have on your resumé," says Dean Wenzel.

It is even possible for members of R.O.T.C. to join the program. However, R.O.T.C. scholarships sometimes require a student to finish the program in four years instead of five. This plan is difficult or perhaps impossible without having a significant amount of credit before coming to the University. One student is following this plan with studies in computer science and Spanish. He says he believes it will be an advantage in his intended military intelligence career.

The five year LAS / engineering program is a great opportunity for students at the University. The benefits and rewards of the program are worth the extra time and work required. If you are tired of exclusively taking math and science classes, this program is definitely worth considering.

Although no plans presently exist to replace Foellinger Auditorium with Engineering Hall, a large number of engineering students are taking the trek "south of Green" in order to engage in studies over and above their technical courses (Photo by Peter Lei).

tech teasers

1. If one third and one fourth of a piece of cloth are black and the remaining eight yards are gray, how long is the bolt?

2. Three men are playing a game where the loser doubles the other two players' money. Each man loses one game in their set of three. How much did each start with?

3.

Complete I am hard
Behead am sound
Behead me again
Then a number is found

4. What monosyllable of five letters will make two monosyllables?

(answers on page 12)

tech notes

Testing Your Cleverness

Do you enjoy spending hours on tricky mathematical problems? If so, then the National Putnam Exam may be for you. This exam, given to approximately 2000 undergraduate students each year, will test your ability to solve many different types of mathematical problems.

The exam consists of 12 problems. given in two three-hour sessions. Topics range from calculus and geometry to more advanced topics, and the exam emphasizes both technique and cleverness, according to Harold Diamond, professor in mathematics. Students work as individuals, but three are selected to determine the University's national ranking. Last year, David Secrest, senior in physics, placed 35th out of a field of 2094, helping the University place 15th overall, Diamond said.

The exam will be held on Saturday, December 5. To help prepare for this year's exam, Diamond is holding weekly study sessions on Wednesdays from 4:00 to 5:00 pm in 143 Altgeld Hall. For more information, contact Harold Diamond at 333-0379.

Overseas Business Tips

Anyone doing business overseas must learn to accept the local customs and be as flexible as possible, according to a publication by the International and Domestic Negotiating Institute in Red Bluff, California. Many times, business people do not realize that things are done differently than they are in the United States.

"American businessmen and businesswomen need to start from scratch and act as if they are preparing to deal with someone from another planet!" said Eugene Mendosa of the Institute. He believes that for people to make successful deals, they must not maintain a traditional viewpoint.

Mendosa recommends several things to help people survive in the international business world. Business people should not get upset just because foreigners do not conduct business as Americans do. They should also not rush immediately into a transaction, and they should avoid being individualistic, according to Mendosa.

To increase the chances of success, Americans should study the etiquette of other cultures, learn all they can about the country's business practices, and be patient, according to Mendosa.

More information is available in a free pamphlet from IDNI by contacting Cynthia Williams, Dept. 5026, International and Domestic Negotiating Institute, P.O. Box 882, Red Bluff, CA 96080.

The Debut of Automotive Ceramics

Alex Magnus

Although difficulties still exist, extensive efforts are being made to further the transition of ceramic materials "from teacups to turbines", because ceramic components allow engines to operate with greater efficiency.

A ceramic car engine? Why would anyone want the material of teacups and bathroom wall tiles to be the engine housing of our cars? Ceramic materials possess properties that have many advantages over the superalloy materials currently being used. Superalloys are materials that exhibit greater strength at high temperatures, 1500° F to 2000° F, than do conventional alloys. If ceramics have so many advantages, then why are they not in production and use now? Ceramics, although highly promising, do suffer from problems in manufacturing and implementation. Governments, private companies, and university professors, such as Professor Dennis Assanis, assistant professor of mechanical engineering at the University of Illinois, are working to overcome some of the major drawbacks that have yet to be resolved. Ceramics is currently one of the most scrutinized technological material science areas. "Solving the fundamental problem is now just (a matter of) time," says Kent Bowen, professor of engineering at Massachusetts Institute of Technology.

Ceramic structural parts have significant advantages over conventional parts. Compared to superalloys, ceramics are lighter and made from cheaper raw materials. They require no lubrication and resist corrosion. Because of their strength at high temperatures and excellent thermal conductivity characteristics, ceramic parts and coatings allow engines to run hotter, allowing for significant fuel savings. According to Professor Assanis, the fuel savings will come from two areas. One is insulating the combustion chamber to conserve heat, and the second is to preserve the exhaust heat by venting it through a turbocharger and back to the engine.

Ceramics can be exposed to temperatures as high as 2500° F without distorting or melting. At 2500° F engines can achieve maximum fuel efficiency. Current parts only run at 2200° F, yielding a 25% decrease in efficiency. Running the engine at higher temperatures will allow the use of alternative energy sources, such as methanol mixed with gasoline. Although this fuel is presently in use, Assanis says that the use of ceramics will make it more feasible.

Gas turbine and diesel engines respond well to higher operating temperatures. The hotter these engines run, the more efficient they become. Since heat is poorly conducted in silicon nitride, heat conventionally wasted in the cooling system could be kept in the cylinder and converted to work. In theory, the thermal efficiency of such a diesel engine could be increased by 30%. In actuality, Professor Assanis has found that an intercooled turbocompound engine derives a modest 4.3% thermal efficiency improvement at a 60% reduction in heat loss.

Turbo chargers can also utilize energy from the engine exhaust. Ceramics could be used to make particularly efficient turbine rotors. Ceramics have a third of the density of steel, and their lower thermal expansion allows for more efficient operation at smaller clearances. The lower inertial mass of the rotor cuts the moment of inertia by 45%. This feature reduces the amount of energy needed to accelerate the turbocharger. It reduces turbocharger lag and ensures agile engine response. Nissan has already developed a silicon nitride rotor and is currently using it in Japan in their 300ZX.

Other companies are also making ceramic engine parts. Ford Motor Co. has successfully tested structural ceramics

Graduate student Joe Grindley coats engine components with ceramic materials at the Plasma Spray Booth in the Ceramic Engineering Building (Photo by Eric Smith).

components, including cylinders, pistons, and pins for over 100 hours in a single cylinder engine. The engine showed potential for up to an 11% improvement in fuel economy, with minimum wear and

low friction. Companies that are funding Assanis's $300,000 ceramic research budget are Caterpillar, General Motors, Chrysler, Amoco, and government agencies.

Porsche has introduced a ceramic-lined exhaust port system in their 944 model. The system insulates the head from the heat in the exhaust system, protects electronic components, and channels more heat to the turbocharger system. It allows for a more efficient engine and a smaller radiator because less heat must be dissipated by the cooling system.

The Department of Defense is also enthusiastic about ceramic engines. Because ceramic engines require less cooling, cooling systems could be eliminated on tanks. This would reduce weight and maintenance costs.

Ceramics research is not new, especially for the silicon nitride family which includes Syalon, a material used to manufacture engine components. Syalon is named after the chemical names of its elements which are: silicon, aluminum, oxygen, and nitrogen (Si-Al-O-N). The secret of this alloy is the alteration of the silicon nitride crystal lattice. Aluminum atoms replace some of the silicon atoms in the structure; oxygen atoms replace some of the nitrogen atoms.

While silicon nitride could be used for making monolithic parts such as a piston head or valve, present research centers on ceramic coatings. Professor Assanis coats pistons, combustion chambers, cylinder heads, and spark ignition components with zirconia of a thickness of 0.5 to 3.0 mm. A thicker coating would increase the chance of failure and diminish the performance parameters. Assanis plans to use this procedure on a one cylnder engine which he received from Australia for $100,000. After coating the pistons, cylinder pads, cylinder head and liner, he may also place a fully ceramic valve in the engine.

Assanis utilizes the facilities of the department of ceramic engineering at the University in manufacturing the coatings for the engine components he uses in his research. As a result, he can better control the process and can measure the properties of the materials himself.

Perhaps the most serious problem with ceramic parts is their tendency to fracture or shatter under stress. Their brittleness presents a serious technical challenge to both ceramic parts producers and ceramic engine designers. Flaws on the order of 5 to 10 microns can lead to failure of ceramic parts. However, at higher operating temperatures, the stress concentrations surrounding a flaw can actually decrease.

Another major problem area is reliability. There are still many unknowns about ceramics and their long term use. Ceramists have difficulty understanding material properties because not enough ceramic auto engine parts are being produced to provide the necessary volume for study.

Processing methods such as injection molding, slip casting, and hot isostatic pressing create more uniform ceramic parts with fewer flaws. Another method of manufacturing is slip casting, a technique based on a powder slurry. It could be used to create thin-walled parts such as cylinder liners. Uniaxial pressing is a third way to manufacture ceramics. The ceramic powder, laced with an organic binder, is compacted in dies under an intense pressure of up to 30,000 psi. It is then sintered at 3772° F in a nitrogen atmosphere, making it tougher than silicon nitride. It can then be diamond ground to precise dimensions.

Reliability may also be hindered by inherent frictional resistance between parts. This property can be controlled at the atomic level. The process involves implanting metal ions into the surface of ceramics in order to provide the lubricants needed to improve engine performance at elevated temperatures. The process adds the desired lubricating quality by bombarding ceramic specimens with metallic ions, atoms or groups of metals. A very thin layer of metal-ceramic alloy with unusual and extremely desirable properties is created. The ion implanted layers, which are metal-ceramic oxides, appear to become quasi-liquid at very high temperatures and thus serve as their own sacrificial lubricant. Materials used include partially stabilized zirconia and hot pressed silicon nitride. This is one processing method that can reduce some of the existing problems that are inherent in ceramic engine component mating.

Whether the payoffs come next year, in 1990, or in the year 2000, many engineers are convinced that ceramics offer valuable weight, wear, and insulation advantages. The problem now is the arduous task of finding the best ceramic material for the job, improving reliability, and then improving the manufacturing process. If advanced ceramics are developed to their potential, it will have a significant impact on the auto industry, car owners, and the nation.

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Tech Teasers Answers

1. 19.2 yards

2. $39, $21, and $12

3. The word *stone* beheaded is *tone*, beheaded again is *one*.

4. Just a few of the monosyllables that will make two monosyllables are heart (hear and art) and stone (tone and one) and Spain (spa and pain). How many more can you name? Write them down and mail them to:

Illinois Technograph
302 Engineering Hall
1308 W. Green St.
Urbana, IL 61801

We will publish the answers we receive i a future issue.

Jim Lefter, visiting professor of civil engineering, has had a challenging and exciting career. After receiving an M.S. degree in civil engineering from the University of Maryland and an M.A. degree in government from Washington University, Lefter worked as a consultant for Bethlehem Steel Company and other industrial and private consulting firms. Later, he worked for the U.S. General Services Administration and as a contracting officer for the Veteran's Administration.

Within his field, Lefter has had many accomplishments: from supervising the construction of hospitals, to restoring a fire—damaged computer room in the Pentagon. With the help of Mete Sozen, professor of civil engineering, and other consultants, he developed new and now widely imitated designs to ensure the safety of buildings during earthquakes. He has also written a book, *A Micro-Based Primer On Structural Behavior*, the result of his love for computers and their uses as engineering tools.

Lefter is now retired from federal service and is teaching as a visiting professor at the University. Lefter is very grateful for this opportunity, as he has always wanted to teach at this campus. Lefter's students get to share in his experience and enthusiasm for his field, which he conveys quite easily, by studying cost estimation in Civil Engineering 318, and design, structural failures, and legal aspects of construction in Civil Engineering 398/498.

Lefter says his wife and children, along with his work, keep him busy. Any hobbies he has time for, such as writing, are work-related. His motto is: "We're always looking for a better way."

Steve Kropp

Tschangho John Kim, professor of urban and regional planning and civil engineering, as well as associate director of international programs and studies, is certainly a world class educator. Originally from Korea, he earned a B.S. in architectural engineering at Hanyang University in 1967. He went on to study urban design at the Vienna Graduate School of Art and proceeded to earn an M.S. in urban planning at the Pratt Institute in New York in 1973. Majoring in transportation, he eventually acquired both an M.S. and a PhD. in urban planning at Princeton University.

Professor Kim usually teaches Urban Planning 407, Planning Evaluation, which studies the economic aspects of planning and transportation policies. However, Kim is currently occupied with a variety of research projects.

He is working on two operations for the National Science Foundation which involve developing efficient algorithms to solve non-linear programming problems. He is also assisting the U.S. Army Corps of Engineers Research Laboratories in the development of the Expert System of Site Selection, which involves artificial intelligence and the creation of new computer software.

Moreover, Kim is engaged in research for the State of Illinois on the economic feasibility of transporting Illinois coal to Asian markets.

Of special interest to Kim is his current position as associate director of international programs and studies (IPS). The objective of IPS is to enable and encourage University staff, faculty, and students to expand research and development of ideas into international forums. Kim is particularly enthusiastic about the study abroad program for undergraduates in which University students work and study in foreign countries. Professor Kim invites all students and especially engineers to "experience study abroad and broaden their horizons."

Among Professor Kim's non-academic goals is the improvement of the University through the creation of a campus-wide bus system for students' safety and convenience. The proposed bus system would enormously assist those living in residence halls and apartments far from campus. In addition, the buses would provide a safe mode of transportation, helping to prevent crime on campus.

Whenever Professor Kim finally does get time off, he likes to relax with sports. He has an intense passion for golf and Kim says, "I never, never, ever skip skiing in the winter."

Ashish Mayenkar

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Illinois Technograph

Illinois **Technograph**

Fall 1988 Volume 104, Issue 1

When Money Stops Talking

Welcome to the University of Illinois. We are one of the nation's finest schools, leading in the research and development of technology which will change the lives of those for generations to come. Indeed, with the construction of the $52 million Beckman Institute, the $17.5 million Digital Computer Laboratory Addition, the $13.7 million Microelectronics Research Center, and other multi-million dollar projects, we will multiply our scientific capabilities tenfold. Undoubtedly, the University of Illinois will be on the cutting edge of science well into the 21st century and so on and so forth.

There you have the sales pitch. Now you get the facts. Financially speaking, the University is experiencing one of its worst periods. Due to the ingenuity of state legislators and university administrators alike, we are on the forefront of a $40 million downsizing of educational programs. In addition to vital instruction being cut, brilliant professors are being drawn to other schools with more lucrative offers. Student affairs and activities, career development and placement, and the Dean's office face severe cutbacks. Centrally held repair and rennovation funds are gone and we cannot purchase needed equipment, library books, and journals.

Since the State of Illinois has refused to pass a new tax bill which would have allowed the University to have the necessary funds, one might ask, "Who is paying for all of the above?" The answer is obvious, the students.

The University of Illinois has had a reputation for maintaining an affordable, yet quality education. Until now. Tuition was raised $300 in 1987 and is threatened with further increases. In fact, the average annual tuition increase between 1978 and 1988 at all other Big Ten schools was $121 while at Illinois it was $169. Fees at the Urbana campus have risen by 139.2 percent since 1978, an annual rate of 10.2 percent. In addition, while the Illinois Board of Education recommends that students tuition should cover one third of the cost of instruction, average undergraduate tuition at the University is about one half the cost of instruction.

To even the most casual of observers then, the Fighting-to-stay-alive-Illini appear to be in a tight squeeze. Who is to blame? Well, let us give credit where credit is due.

First, we must thank the the State of Illinois, and especially Governor James Thompson. Thank them, not for vetoing a larger tax bill which would have funded our school, but for their less than practical allocation of state funds. Thank them for building the State of Illinois Center in Chicago which cost twice its original estimate. Thank them for accepting the highest rather than the lowest bid for the construction of the Department of Lottery Building, and for spending $350,000 of the State's Road Fund on the Executive Mansion rose garden. Never mind the University of Illinois which is desperately trying to maintain existing programs. Never mind the adverse effect of this on the thousands of individuals who are to play important roles in the state's as well as the country's future. Point made?

Secondly, we must thank University administrators. To this group I must say that the development of better foresight is in order. Upon initiation of new programs and multi-million dollar construction projects, priorities should be clearly assesed and allocations analyzed. In simpler words, upgrade what already exists rather than begin endeavours which may never reach completion. State and capital development bond funds need not be expended merely because they exist. Current programs in need of financial assistance should be investigated more thoroughly. Overcrowded classrooms, declining faculty, removal and replacement of unintelligible teaching assistants as well as maintainance and rennovation of existing facilities are more important than say, the Beckman Institute which aside from Mr. Beckman's contribution, cost Illinois $13 million in addition to annual operational costs. The University must also learn not to depend on supposed tax increases by the State which would provide our required funding. This would mean stabilizing university growth rather than infeasibly expanding and setting aside emergency economic resources.

To groups such as the University Board of Trustees and specifically the Task Force On Campus Priorities, which was responsible for a report on the studies of downsizing, but claimed that they didn't know they were supposed to present the report: I advise that in future meetings, spell out exactly what is to be done. Efficiency is warranted in this economic crisis.

Lastly, students should learn from the developments of the past few years that involvement and input in State and University affairs is important. Organizations such as Student Government Association, LAS Council, United Progressives, as well as College Republicans and Democrats should voice their concerns more loudly, and more actively seek to influence State and University decision makers.

Clearly, University economics is a science of complex variables. There are no rights or wrongs, but more often compromises that might possibly work. The underlying truth or bottom line, if you will, in this chaos is that practicality must replace utopian visions.

Kiefer K. Mayenkar

Illinois Technograph invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions are also welcome. Letters must be signed, but names will be withheld on request.

Building From the Aspirations of Beckman

The area north of Green Street at the University of Illinois Urbana-Champaign campus is rapidly changing. With the addition to the Digital Computer Laboratory, the Microelectronics Research Center and the Arnold O. and Mabel M. Beckman Institute for Advanced Science and Technology, the engineering campus is shaping up. The Beckman Institute is by far the largest enhancement to the area. It is built on an innovative idea designed in part to usher the University of Illinois into the 21st century.

Arnold Beckman is a University of Illinois alumnus with a B.S. degree in Chemical Engineering and a M.S. degree in Physical Chemistry. He went on to receive his Ph.D. from the California Institute of Technology. In 1935, while teaching chemical engineering at Caltech, he formed his company, Beckman Instruments. Since then Beckman has amassed a half-billion dollar fortune due in most part to the sale of his $618 million company in 1982.

Arnold Beckman is not hoarding his fortune, however. Instead, he has created the Beckman Foundation to disperse a portion of his funds to institutions, primarily universitities, for research and development. As head of the foundation Beckman believes in taking a personal approach to selecting recipients; he himself reviews each application. During his in depth analysis of an institution's financial responsibility, he mainly seeks those that will utilize a contribution most effectively.

In the past, the Foundation made a donation to the supercomputing center at the University of Illinois. The supercomputer has expanded the capabilities of researchers on campus and provided a network of knowledge and information. The center has placed the University at the pinnacle of computer research.

The Beckman Institute, made possible by a $40 million contribution from the Foundation and approximately $13 million from the state, is expected to bring the University to the apex of another field: the understanding of both human and artificial intelligence. It will focus on interdisciplinary research bonding biology, behavior, and cognition to material science, computers, and computation. Specific studies will include neuronal pattern analysis, materials chemistry approach to submicron structures, and visual processing in complex systems.

No researcher will be awarded a permenant position at Beckman; each will still be tenured in a department on campus, be it electrical engineering, cognitive science or philosophy. The faculty members will have a position for a specific, but extendable, period of time. This will assure that the staff remains both fresh and competitive. The building was designed to accommodate this manner of operation. With the exception of basic operating equipment, such as wiring, plumbing, and venting, the rooms of the building are not specifically designated for any one purpose.

Researchers will be responsible for acquiring their own equipment through funding from federal and private research grants. This allowed the University to invest a large portion of the $53 million toward the building itself. The estimated $7 to $8 million per year operating costs should be the only expenditures that the University must render.

The concept of an interdisciplinary research facility came about five years ago from Lewis Barron of the University of Illinois Foundation. The pushing done by University President Stanley Ikenberry, Director Theodore Brown, and Beckman himself has resulted in a 313,000 square foot building located on Illinois field, south of University Avenue and east of Wright Street. The Institute is expected to be completed by January of 1989, only two years after construction began.

The Beckman Institute is expected to greatly enhance the north end of the University. The combination of the Institute, the proposed quadrangle, and the Engineering Complex should make the area north of Green Street a place for students, faculty and others to relax between designing planes and crushing atoms.

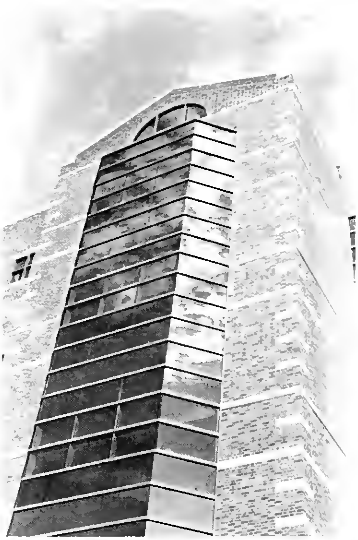
Most feel the Institute will have a positive influence on students. It will bring researchers from across the country, allowing students to broaden their knowledge in a wide variety of disciplines. Students will gain opportunities to learn from such researchers on an individual basis, as well as acquire hands-on experience.

At a statue unveiling ceremony on October 8, 1988, Arnold Beckman declared, "My wife and I are indebted to the University for giving us the opportunity to be a part of this great concept." Dr. Beckman neglected the fact that the University of Illinois, its faculty and students, are indebted to him. Were it not for the generousity and drive of Dr. Beckman, the Beckman Institute for Advanced Science and Technology would never have been realized. It could have been an idea tossed around for years, or a project that was cancelled due to lack of funding. As it is, the University should be proud to have a place where ideas from different disciplines can be shared, perhaps over lunch, to find the keys to understanding human and artificial intelligence.

Julie Reyer and Ken Skodacek

tech visions

After five years of planning and waiting, the Beckman Institute for Advanced Science and Technology nears completion



Photographs by Julie Reyer and Ken Horlander

Riding the Wind

Long ago the Phoenicians, ancient seafarers, sailed on the Mediterranean Sea. Their crude wooden ships were slow and inefficient. Since then, Man has come a long way in sailing technology. Advancements in aeronautics and materials have made sailing ships faster and better. Perhaps the best examples of how far Man has come are two ships of the America's Cup, a prestigious yachting event which occurred two months ago. These ships, the *Stars and Stripes* and the *New Zealand*, are the fastest and most modern sailing ships yet built by Man.

The *New Zealand*, although the loser of the America's Cup, is still a sailing vessel to be respected and admired. More than likely, she is the fastest sailing monohull in the world, able to reach a speed near 25 miles per hour. Her ability for speed comes from her high-tech construction and also from her size. The latter is what catches one's attention first. For a yacht, the *New Zealand* is a big ship. A typical 12-Meter yacht, the traditional type of boat used in the America's Cup, is 65 feet long and needs a crew of 11. In comparison, the *New Zealand* stretches 132 feet in length and has a crew of 40. Her mast reaches a height of 150 feet, holding up sails that cover about 20,000 square feet. This large size enables the sails, which can literally crush a man with their sheer weight, to provide an extraordinary amount of thrust for the *New Zealand*.

It is important to note, however, that being big does not mean the *New Zealand* is heavy. In fact, the *New Zealand* only weighs around 70,000 pounds, close to the 60,000 pound weight of a typical 12-Meter yacht. The "low" weight can be attributed to the use of a high-tech material, carbon fiber. This is a lightweight but strong material. The use of innovative materials also extends to the sails, which are made out of Kevlar and Mylar. The former provides strength, the latter light weight.

The use of technology in the *New Zealand* goes beyond just materials. For instance, the hull and keel of the *New Zealand* were designed by computer to be streamlined like an airplane. The final results are a hull only 14 feet wide at the waterline and a low drag keel. In addition the *New Zealand*, following the lead of modern airplanes and cars, comes equipped with three computers. One keeps track of boat speed, both true and optimum. The second computer measures stress being placed on the ship's frame. The third works with miniature TV cameras placed atop the mast, taking images of the sails and comparing them with "target" shapes. As a result, the crew of the *New Zealand* can then adjust the sails for optimal performance.

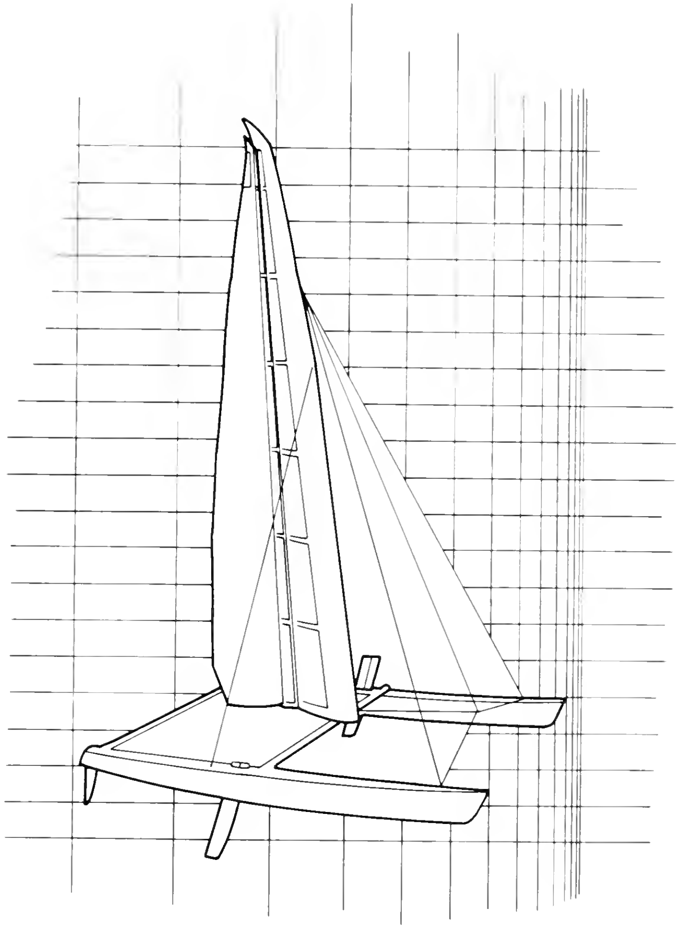
Compared to the *Stars and Stripes*, however, the *New Zealand* is a step behind in speed and technology. The difference in speed is because the *Stars and Stripes* is in a different class of sailing ships than the *New Zealand*. The *Stars and Stripes* is a catamaran, a two hulled ship, whereas the *New Zealand* is a monohull. According to Professor Allen Ormsbee of Aeronautical and Astronautical Engineering at the University of Illinois, a catamaran is the faster of the two because a ship's speed is limited by its length and width. A sailing ship has a transverse wave train, which originates at the bow, attached to the hull. As the ship's speed increases, the wave speed increases as does the period of the waves. When the period of the waves approaches the hull length, the drag of the hull increases rapidly to large values, creating a speed barrier as the drag prevents the ship from accelerating. Thus, a long hull is desired as a long hulled ship can reach higher speed before the period of the waves approaches the hull length and prevents the ship from accelerating. The *Stars and Stripes* has two long hulls. This is a furthur advantage in that drag can be reduced without losing stability. A monohull must have a hull that is wide enough to be stable while a catamaran can have two narrow hulls placed apart for stability; a wide hull has more drag than two narrow ones.

The *Stars and Stripes*' hulls are made out of carbon fiber like the *New Zealand*, but the similarities end there. Besides being a catamaran, the most obvious difference between the two ships is the type of sail. The *Stars and Stripes* has a wingmast, or rigid sail. Although wingmasts have been around for about ten years, there has never been one designed by a top aeronautical engineer. The *Stars and Stripes*' wingmast was designed by Burt Rutan, the designer of the Voyager, the plane that flew around the world without refueling. Made of carbon fiber, Mylar, and Dacron, the wingmast is essentially a giant, vertical wing. It rises 108 feet into the air and is larger than a wing of a Boeing 747. Whereas an airplane wing provides lift, the sail provides horizontal thrust. To enhance performance, the *Stars and Stripes*' wingmast has a slotted flap, also known by some as a Fowler flap. A top view of the wingmast would show that it is essentially comprised of two airfoils with a slot between the two. The trailing edge of the first airfoil, the slat, controls the size of the slot. The two airfoils work in conjunction with the slat to to improve performance of the wingmast. As explained by Professor Ormsbee, the first airfoil splits the air, creating low pressure on one side and high pressure on the other. The slot between the two airfoils allows the air from the high pressure side to travel to the low pressure side in a high speed stream. This is known as the Venturi effect. The stream of air has low pressure, thus putting a pressure difference on either side of the second airfoil and adding to the horizontal thrust. This is similar to an airplane deploying its flaps during takeoff.

The wingmast, along with the advantages that a catamaran has over a monohull, makes the *Stars and Stripes* possibly the fastest wind-powered ship in the world. She can reach a speed of around 30 miles per hour. That may not seem fast to many considering there are cars that can travel over 200 miles per hour and jets that can fly three times the speed of sound, but 30 miles per hour is still fast enough to outrace any man. A world class swimmer moves about 4 miles per hour while a top sprinter can run only about 20 miles per hour. In comparison, 30 miles per hour is plenty fast, enough to pull a water skier.

If the Phoenicians could somehow be brought to the present, they would be amazed by the *New Zealand* and even more amazed by the *Stars and Stripes*. The use of high-tech equipment as well as exotic materials has pushed the limits of sailing farther away. Man has come a long way in sailing technology and will probably go even further in riding the wind.

Calvin Huang



Drawing of Stars and Stripes by Brian Switzer

A WISE Summer In the Nation's Capitol

Washington Internship for Students of Engineering (WISE) provides a unique opportunity for students to learn the role engineers play in the formation of national legislation. Last summer, 16 participants from universities around the country spent ten weeks in Washington, D.C., meeting with government officials, corporate representatives and lobbyists. The WISE program is coordinated by the American Society for Engineering Education (ASEE) and is funded by engineering societies such as the American Society of Civil Engineers (ASCE). The WISE program began eight years ago in an attempt to bridge the gap between the world of technology and the complex legislative process. The goal of the WISE program is to introduce engineering students to the manner in which the government develops policy on technical issues and the existing and potential role of professional engineers in that process.

Engineering societies are aware of the tremendous impact that federal decisions can have on the members of their profession. To keep members informed on important issues, many societies publish a column in their monthly magazines on the 'hot' issues in Washington D.C. Some societies go one step further and inform their members of pertinent legislative issues through regular mailings. Societies are also getting future engineers interested in engineering public policy issues by sponsoring students in the WISE program.

During the course of the summer, participants in the WISE program attended meetings, traveled and worked on independent research projects. The 1988 interns met with over 50 representatives from government and industry. Among these were an Environmental Protection Agency Administrator, officials at the Nuclear Regulatory Commission, Governor Sununu of New Hampshire, lobbyists, auto industry executives, State Department officials and Capitol Hill staffers. As well as meeting these leaders, the 1988 interns toured Three Mile Island, the White House, and Gettysburg. Some students with free time visited the museums and monuments in Washington, D.C., and traveled along the east coast to New York, Atlantic City and Virginia Beach.

Students also experience the science and history of our nation in the Smithsonian Institute

In addition to attending meetings and sightseeing, each student prepared a research project on an engineering-public policy issue of concern to their sponsoring society. Students researched their issues by collecting documents from government agencies and special interest groups, and interviewing experts on their topic. From their research, each student prepared a 25-30 page report, and at the end of the summer, gave an oral presentation defending their conclusions.

The diverse interests of the 1988 interns was evident in the variety of public policy topics that the students researched. Some of the proposals included a computer model that showed the cost-savings associated with a prison work-release program for non-violent offenders, the effects of smoking on indoor air quality, policy implications of a new type of nuclear reactor, medical device legislation, infrastructure financing, and a critique of pending groundwater legislation. Each student selected their topic with the help of their sponsoring society, and many of the papers will be published in society publications.

Several of the 1988 interns have hopes of pursuing careers in Washington D.C., but the majority of students are planning to work as engineers after completing their education. Regardless of their future aspirations, there is no doubt that

participation in the WISE program was beneficial to all of the students involved. The experience taught the interns the basics of the complex legislative process, and more importantly, taught them how important it is for everyone, especially engineers, to voice their opinions to congress.

The WISE program is a wonderful opportunity for any engineering student who is looking for a productive, educational, and enjoyable way to spend their summer. The program is open to junior engineering students and faculty members. Sixteen students and one faculty member are chosen each year. A stipend is provided that is sufficient to cover all housing, travel and living expenses incurred during the ten-week stay in Washington D.C. Those interested in participating in the 1989 WISE program must submit an application by December 20, 1988. The selection of the participants is based on the student's extracurricular activities, academic record, letters of recommendation and a short essay. Applicaions can be obtained from Tim Turner of ASEE at (202) 293-7080.

Laurie Hellmer, a senior in Civil Engineering, participated in the 1988 WISE program.

While learning about the effects of engineering on legislation, WISE students get the opportunity to see the nation's capital. Pictured is the United States Capitol Building.

Engineering Societies that Sponsored 1988 WISE Interns

American Institute of Chemical Engineers (1 student)
American Nuclear Society (2)
American Society of Civil Engineers (1)
American Society for Engineering Education (1)
American Society of Heating, Refrigerating and Air Conditioning Engineers (1)
American Society for Testing and Materials (2)
Institute of Electrical and Electronics Engineers (2)
Institute of Environmental Sciences (1)
National Society of Professional Engineers (1)
Operations Research Society of America (1)
Society of Automotive Engineers (3)

Laurie Hellmer

Engineering Family Album

This sampling of engineering societies gives a taste of the wide variety of activities that can spice up the life of an engineering student.

Association for Computing Machinery (ACM)

The Student Branch of this organization is dedicated to the education and understanding of computer science and applications -- "computing science" -- in society. The society holds many activities such as a Career Day, Professor Symposia, and has many special interest groups dealing with such various topics as artificial intelligence, music synthesis, and computer graphics. The society, by working in close association with the Department of Computer Science, is capable of providing both undergraduate and graduate students with an effective channel of communications and continuing education. For more information about the society, contact Rich Bloch at 356-2477.

Associated General Contractors (AGC)

The student chapter of the Associated General Contractors is a group that tries to provide for the many aspects of one's education that are not taught in the classroom. Made up of civil engineers, this society sponsors social activities that bring together different people who may one day be working together.

The main emphasis of the group is to give civil engineers practical experience through community service. The group tries to perform one project per year in which its members are completely in charge of the design, methods, bidding, and labor. Since the labor is donated, the community benefits as much as the students. For more information, contact John Shales at 356-2477.

Alpha Pi Mu

Alpha Pi Mu, the industrial engineering honor society, is composed of juniors and seniors who rank in the top 25 and 30 percent of their industria engineering classes, respectively. The organazation was founded in order to give recognition to students who have shown exceptional academic achievement and participation in extra-curricular activities. Alpha Pi Mu gives its members a wide variety of activities to participate in such as peer advising, meetings with guest speakers, social activities, and participation in the Engineering Open House project. For more information, contact Alison Odom 337-5985.

American Ceramic Society, Student Branch (SBACS)

The Student Branch of the American Ceramic Society was founded at the University of Illinois in 1915. SBACS provides students with information on past and current developments in ceramic engineering and related fields, the activities of the American Ceramic Society, cooperative events with other engineering branches, and a spirit of fellowship through monthly meetings and various functions. The SBACS also sponsors such activities as the Engineering Open House project, a Tailgreat tailgate, a fall hayride, intermural sports teams, and a traditional pig roast. For more information, contact Stacey Trella at 384-5793.

American Institute of Aeronautics and Astronautics (AIAA)

AIAA is a national organization for students expressing an interest in aeronautics or the aerospace industry. The AIAA has monthly meetings with guest speakers from major aeronautical corporations and sponsors fequent plant trips for club members. The society also provides many social functions that give students a chance to meet fellow students and professors on an informal basis. For more information, contact Beth Baird at 356-8725.

American Institute of Chemical Engineers (AICHE)

AICHE keeps chemical engineering students informed in a variety of ways. Plant trips and guest speakers at meetings give students contact with the "real" chemical engineering world. For academic help here at the University, the group offers peer advising on courses. Social events give a welcome break from the pressure of classes. For more information, contact Scott Goffinet at 333-1587.

Association of Minority Students in Engineering (AMSIE)

Many opportunities are open to minorities in engineering, and AMSIE helps locate these opportunities. Not only does the society offer peer counseling,but it also offers information on writing a good resume and seeking out jobs in a variety of areas of engineering. For more information, contact Jeff Johnson at 337-7434.

American Society of Agricultural Engineers (ASAE)

The ASAE is an organization mostly composed of agricultural engineers and some ag. mechanic students, but it is open to students in all fields of interests. The society has student branch meetings every three weeks. The ASAE promotes student-faculty interactions by promoting and funding many department gatherings such as a fall picnic, student-staff welcome night, and a spring banquet. The club also promotes school activities such as sporting events, Engineering Open House, and student welcome nights. Likewise, community interaction is very important, and is usually achieved by blood drives and lawnmower summerizing. Contact Jim Sutor at 367-2208 for more information.

American Society of Civil Engineers (ASCE)

ASCE is the liason between students and professionals in civil engineering. With its various activities, it gives students a feel for civil engineering that they cannot get in the classroom. The Engineer-in-Training (EIT) refresher course helps students survive the EIT exam. Besides academic activities, the society has various social activities. Contact Randall Romach at 359-2208 for more information.

American Society of Mechanical Engineers (ASME)

This national professional society has a student chapter here on campus. It gives students access to papers from the national chapter. Monthly meetings offer speakers from industry. The society also sponsors an Engineer-in-Training refresher course. For more information, contact Michael Chu at 367-3138.

Chi Epsilon

Chi Epsilon is the civil engineering honor society. Chi Epsilon has three meetings each semester and is involved in several activities. Every year, Chi Epsilon takes pictures of all seniors in civil engineering for the senior picture case. In the fall, the chapter hosts the Purdue chapter in volleyball, and in the spring, Chi Epsilon travels to Purdue to play softball. Several new programs are being started to promote student faculty relations, such as a faculty help day and the "Take a Professor to Lunch" program. Chi Epsilon , besides starting a test file, also has many social events such as happy hours and parties. Contact Karen Mitchell at 356-8725 for more information.

Engineering Freshman Committee (EFC)

Engineering Freshman Committee is partially what its name implies but also much more. Sponsored by Engineering Council, EFC is an organization designed to be a "touchstone" for engineering students new to curriculum and unfamiliar with their majors. The bimonthly meetings are open to all freshman engineering students. The meetings inform members of the current activities of EFC as well as present a guest speaker. In addition, EFC publishes a bimonthly newsletter, sponsors contests and other social events, contributes to the success of Engineering Open House, and organizes the Colege of Engineering Blood Drive. For more information, contact Jason Struthers at 333-3558.

Engineering in Medicine and Biology Society

Ten years ago, a small group of students formed the bioengineering society to promote the application of engineering in life sciences. This year the group has joined a national professional organization, the Engineering in Medicine and Biology Society. Though this move has changed the society's name, its purpose remains the same. The EMBS provides students an opportunity to explore the field of bioengineering by presenting speakers from academia and business, organizing trips to manufacturers and hospitals, supporting independent study projects, participating in community service projects on and off campus, and promoting student-faculty interaction in professional and social settings. Because students also learn from one another, the EMBS also offers peer couseling and tutoring, coordinates with other interest groups, and plans social events. Students in the EMBS not only learn about bioengineering, they also inform others about the field through extensive participation in Engineering Open House.

Last year bioengineering won Best Department Honors in Engineering Open House competition, and the EMBS was named Best Profesional Society by the Engineering Council. This year the EMBS is challenging its members to "make the best better!"

Institute of Electrical and Electronic Engineers (IEEE)

IEEE is a professional society involved in various aspects of electrical engineering in both education and industry. The IEEE chapter at the University is one of the largest and most active of the chapters in the United States. The student chapter plans various career related activities throughout the year. The IEEE offers speakers at meetings, plant trips, and student related publications and programs. For more information, contact Bob Tata at 328-3210.

Illinois Society of General Engineers (ISGE)

"Something for Everyone" is this year's ISGE theme. ISGE sponsors sports, happy hours on Fridays, informational sessions for underclassmen, and campus affairs projects.

To date, ISGE held two meals with speakers for freshmen, one on "Academic Success" and the other on the general engineering curriculum. The society has already hosted it's first speaker from industry who spoke about "Opening Shop - A Career Option". For more information, contact Louis Wozniak at 586-4289.

International Society of Hybrid Microelectronics (ISHM)

One of the main functions of the International Society of Hybrid Microelectronics is to promote an awareness to students of the existence of hybrid microelectronics. It is available to those interested in microeecectronics including those who have not yet been exposed to hybrid microelectronics. Each spring ISHM participates in the nationally renowned Engineering Open House, an event that ISHM does consistently well in. Throughout the school year, ISHM enjoys invititng its members to several social gatherings which give members a chance to meet and talk in a friendly atmosphere. In addition, ISHM attempts to sponsor guest speakers that discuss current technology and field trips to companies involved with hybrid microelectronics.

Keramos

Keramos is the Ceramic Engineering Honorary Fraternity. The local chapter has been very active this semester. In September, Keramos held a "Get To Know The Department" party, and in October, we sponsored an event in Tau Beta Pi's Engineering Olympics. The society also sold textbooks to students at discounted prices.

Current Keramos projects include the compilation of a resume book that will be sent to over 200 companies. This book will include all degree levels as well as students interested in summer or co-op work. Keramos is also in the process of setting up a file system and compiling faculty evaluation questionaires. Keramos is currently trying to gather various ceramic parts from corporations which we will display in the showcases in the Ceramic Engineering building. Contact Sharron Tracy at 328-4798 for more information.

Physics Society (PS)

Our society is basically an academic organization. We administer to anyone interested in the field of physics or related fields. We host speakers on graduate schools, present research, and popular areas of concern. We sponsor one trip a semester to research firms like Argonne National Laboratory and Fermilab. We represent the Physics Department in the Engineering Open House. In addition to our academics, we also have some pure fun with happy hours, bowling nights, ice skating or the like. All are welcome to participate. Drop by the PS office at 211 Loomis Lab for more information.

Sigma Gamma Tau

Sigma Gamma Tau is an honor society for aerosapce engineers. It seeks to identify and recognize achievement and excellence in the aerospace field. The requirement for admission is to be in the top 25 percent of the junior class,top 33 percent of the senior class, or a graduate student in good standing. Activities that SGT is involved in are a paper airplane contest in the spring, a highly successful tutoring program for all AAE classes, a winter banquet for all new initiates, an Engineering Open House Project, and various social activities. For more information, contact David Andreshak at 398-1184.

Society of Hispanic Professional Engineers (SHPE)

The Society of Hispanic Professional Engineers(SHPE) is a national organization which supports the development of hispanic engineers and scientists. The student chapter at the University is focused on the retention and recruitment of students in the engineering and science disciplines. There are a wide variety of positions including a regional and national representative. Some of the SHPE activities include Engineering Open House projects, corporate speakers, career workshops, and notional and regional seminars. For further information, contact Assistant Dean of Engineering, Paul E. Parker, at 333-2280.

Society of Women Engineers (SWE)

This professional engineering society, open to both men and women, exists to support women engineers. The University's branch recruits women engineers to speak about engineering careers and the resources available to women engineers. For more information, call Lorelei Hunt at 332-4415.

Illinois Technograph

As an interdisciplinary magazine, the *Technograph* is dedicated to bringing engineering students the latest information about technology. The *Technograph* has positions for students with writing skills, interest in photography, or business acumen. Students interested in becoming published author or photographer should call Kiefer Mayenkar at 332-4035.

Tau Beta Pi

This honorary society was founded in 1885 to recognize outstanding academic achievement in juniors, seniors, and graduate students. The Illinois Alpha Chapter offers a variety of services and projects to benefit its members, the University, as well as the community. For underclassman of all majors, Tau Beta Pi has a free tutoring system and also sponsers Outstanding Freshman and Sophomore Awards. This year the Alpha Chapter coordinated the First Annual Engineering Olympics which involved 200 engineering students from all curricula. General meetings for this organization are held once a month with speakers from industry. This spring they will hold a Summer Job Fair for all engineers on February 20. For more information on Tau Beta Pi, contact Michelle Ohms at 333-3558.

Triangle Fraternity

Triangle is a social fraternity composed of engineering, architecture, and science majors who are looking for more from their college experience. The Triangle Brotherhood offers a wide range of social, athletic, and leadership activities while maintaining high academic standards. Students interested in discovering the advantages of Triangle should contact Rush Chairman Rubin Mesa at 384-9668.

University of Illinois Metallurgical Society (UIMS)

This is an academic organization which aids students in learning about metallurgical engineering and materials science outside the classroom. For example, this year members attended the World Materials Congress in Chicago and toured the Burns Harbor Bethlehem Steel Plant. Members of UIMS also have opportunities to get to know their professors and classmates on more a personal level through a variety of activities including the annual fall picnic, spring pig roast, and sports tournaments. Meetings are usually held the first Thursday of every month at 6:30 in 119 MMB. For more information about UIMS, contact Sherry Brown at 332-6041.

Jack A. Gidding

1. Which of the following poker hands is the best? (on an ordinary 52 card deck with no wild cards)
a)AH AD AS AC KD KS
b)AH AD AS AC QS QC
c)AH AD AS AC 6S 6D
d)AH AD AS AC 3D 3S
2. What is the only seven digit number that, when its digits are reversed, becomes a factor of itself? (excluding numbers that read the same forward and backward).
3. Four people have ages that are all prime numbers and add to 50. Assuming one of the ages is already known, how old are the four people?
4. How many trees can be put on a 100 foot square field if, from center to center, no two trees are closer than ten feet apart? (assume trees can be centered on the borders of the field).
5. In order for Mary to take the shortest route to class, she crosses a street, then crosses the same street again. How is this possibly the shortest route?
6. How is it possible to lay a book flat on the floor of an empty room in a place where the book cannot be jumped over?
7. A man is killed by a rock without the rock ever touching him. How is this possible?

What's NExT?

On Wednesday, October 12, Steven P. Jobs, the former chairman of Apple Computer Co., unveiled his latest innovation to the computer market. After Jobs was ousted from Apple, the company he founded in his garage, he and four other ex-Apple designers began creation on a new computer and company, both named NeXT.

The NeXT computer was created to compete with desktop systems such as the Apple Macintosh II, the Compaq 386, and Sun Workstations. The NeXT unit boasts a 25MHz processor speed and a standard 8 megabyte(Mb) of memory, expandable to 16 Mb. The NeXT operates on Motorola 68030 32 bit microprocessor, a Motorola 68882 math coprocessor for extended number handling capacity, and a Motorola 56001 Digital Signal Processor(DSP).

The 56001 DSP handles most of the communication aspects of the computer and allows the NeXT several extended capabilities such as speech synthesis, sound output in digital CD format (44.1 kHz), and FAX output through the machine's built-in 9600 baud modem.

The actual machine is black and has a black 17'' Sony gray scale monitor. The 12'' black cube that contains the CPU is manufactured out of magnesium. This is said to dissipate heat buildup easier and properly block electromagnetic radiation.

The NeXT uses a 286 Mb ''Magneto-Optical'' Drive for informtion storage. The optical drive has the capability to store approximately 100,000 pages on a disk that is similar to an audio compact disc. This optical drive, developed by Sony and NeXT, implements two additional integrated circuits that speed disk access.

The NeXT also contains an Ethernet interface for networking applications and has available an optional laser printer. Rumored to be in development for the NeXT is an optional color graphics card.

Besides a form of the UNIX Operating System, each computer is equipped with a variety of software that computer users will find very useful. The computer comes with a music kit, a word processor, database, electronic mail program, dictionary, thesaurus, Oxford Dictionary of Quotations, and the complete works of Shakespeare. Also included is the Objective C Compiler and a copy of Mathematica, the equation solving program written by University of Illinois Physics Professor, Stephan Wolfram.

The best part about the NeXT, besides the wide variety of hardware and software, is probably the price of $6,500. This price makes the NeXT very competitive with the other machines. The NeXT, for a time however, will only be available on college campuses. After Jobs has catered to the universities, he will begin to make it available to other customers.

Jack A. Gidding

Creating Rehabilitation Devices

A disabled man who could not talk or move used one finger to type pages describing his life into a computer. In the past, a caretaker had to help him by moving the computer to his bed.

University of Illinois engineering students designed a mechanical table to move the computer to the patient's chest level at the push of a button. The man now works for a computer company and manipulates data without leaving his bed.

U. of I. engineering students are creating and modifying devices for disabled people in the community and nearby cities, thanks to a special program funded by the National Science Foundation. Mark Strauss, a University of Illinois Professor of Rehabilitation Education Services and General Engineering, received a five year $109,000 NSF grant to buy supplies and advertise the service to disabled community people.

The purpose of the grant is two-fold, Strauss said. "One is to provide technical expertise for disabled people," he said. "The other is to provide some real life experience for engineering students. It is amazing how some common sense skills are not taught in the classrooms."

Students volunteer to work on projects and receive college credit. The program started in June and students have already helped another university student injured in a car accident. The student can only speak in a whisper because his larynx was damaged in the accident. The engineering students designed a headset with an amplifier and attached a speaker to his wheelchair. The student can now actively participate in class discussions.

Students are also devising a harness for a Springfield photographer, after a stroke paralyzed the entire left side of his body. The harness will position the camera in front of his face so the photographer can use his one free hand to focus the camera and take pictures.

Other student projects range from a musical pH meter to check the water in a swimming pool, to an instrument that can temporarily bolt a wheelchair to the ground so a handicapped student can open the heavy doors of campus buildings.

"After we build the device, we give it to the needy person free," Strauss said. The student who designs the best project will win a free trip to a national engineering conference to present his or her work.

Currently, there are more projects to work on than student volunteers, Strauss said. Students interested in participating in the program should see Strauss at 124 Rehabiliation Education Center or call him at 333-4613.

Iris Chang

Cancer Detected By Magnet

A recycled magnet can help University of Illinois researchers detect cancer in its early stages.

Dr. Harold M. Swartz, Professor of Medicine and Biophysics, received a magnet previously used for magnetic resonance imaging and applied it to electron spin resonance.

"What is currently lacking in medical technology is a good way to measure oxygen concentration in the tissue of animals," Swartz said.

Many diseases, such as strokes, tumors and inflammations, are characterized by lower oxygen concentrations, he said. Electron spin resonance is used to measure concentrations of unpaired electrons. "It is especially sensitive to oxygen because it has two unpaired electrons," Swartz said.

Even the smallest cancer growth, the earliest collection of cells, will decrease the oxygen concentration in that spot. Strokes and heart attacks decrease blood flow and will cut off oxygen to the brain and heart.

The magnet pinpoints the area of low oxygen concentration. In the past, researchers could only study small animals such as mice by placing them between the poles of magnets. The larger magnet enables Swartz and his research team to study the cells of bigger animals like dogs.

Paul C. Lauterburg, the inventor of magnetic resonance imaging and the director of the University of Illinois Biomedical Magnetic Resonance Laboratory, gave the magnet to Swartz's Electron Spin Resonance Center.

Iris Chang

ANSWERS

1. Since all three hands cannot occur in the same round, they must be taken as separate cases. By counting the number of hands that can beat each, choice c is the best.
2. 9899901
3. The ages are 2,2,3 and 43. The oldest age must be 43 or there would be more than one possibility.
4. By alternating rows of ten and eleven trees each, forming equilateral triangles between them, 128 trees can be fit into the field.
5. Mary walks on Goodwin, just south of Gregory, where the road has a curve in it. By walking in a straight line, she will cross the street twice.
6. Put the book in a corner of the room.
7. The man is Superman and the rock is Kryptonite.

Dean Wagner

Wearing a smile as he teaches Biochemistry 352, Professor H.E. Conrad lectures over the structure of proteins. As Associate Head of the University of Illinois Department of Biochemistry, Prof. Conrad has taught nearly every course offered by the Biochemistry Department during his 30 years here.

Originally from Washington D.C., Conrad received his B.S. from Louisiana State University, and went on to receive his Ph.D. from Purdue University in 1954. He came to the University of Illinois in 1958 to perform postdoctoral work and received his first faculty appointment in 1962. He has lived in Illinois ever since.

Whether working on nutritional studies in the military during the Korean War, or on vitamins during a period in which he worked in industry, Prof. Conrad has always been involved in biochemistry. His interest in science was stimulated by his father, also a scientist, who worked for the Dept. of Agriculture studying the physical chemistry of cellulose.

Heading a research group consisting of five graduate students and four postdoctoral students, Prof. Conrad concentrates on two major areas of research stemming from his earlier doctoral work on polysaccharides.

The first area of research regards heparan sulfate, a sulfated mucopolysaccharide that exhibits blood anticoagulant activity. Heparan sulfate is synthesized in hepatocytes, or liver cells, and in all other animal cells. Prof. Conrad's research has shown that heparan sulfate appears in the nuclei of hepatocytes and changes the growth behavior of the cells. Although studies on the biosynthesis, secretion, maturation and degradation of heparan sulfate continue, research at present concentrates on the possible functions of this polysaccharide in the regulation of cell growth and metabolism.

Chondroitin sulfate and collagen represent the other area of research for the Conrad team. Chondrocytes, or cartilage cells, produce the chondroitin sulfate and collagen which give rise to the extracellular cartilage matrix in which bone calcification takes place. Bones calcify from the center outward, depositing calcium phosphate in this extracellular matrix. This is one of the main reasons that bones break near the ends where they have not yet fully calcified. Research presently is directed toward the factors which regulate chondroitin sulfate and collagen synthesis prior to bone calcification.

Outside of research, Prof. Conrad enjoys sporting events, but has long since retired from his active participation of earlier days on the Biochemistry Department's softball team.

Mon Lee

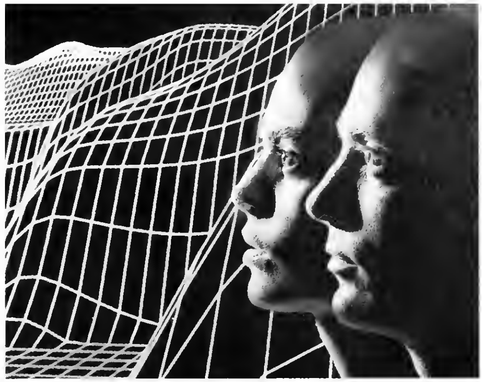
Shee-Mang Yen, Professor of Aeronautical and Astronautical Engineering, has taught at the University of Illinois for 32 years. He received his undergraduate degree at Chiao-Tung University in China. In 1947, he came to the University for graduate work, and later earned his Ph.D. in mechanical engineering. Yen left the University for five years to teach at Kansas State University, but returned by 1956 to teach in the Department of Aeronautical and Astronautical Engineering. Now his classes concentrate mainly on viscous flows and rarefied gas dynamics.

Professor Yen has many interesting accomplishments. He has been a consultant, and has worked with many large corporations, such as McDonnell Douglas, Boeing Aircraft, and NASA. Some of his past research has involved redesigning the propulsion system for the F-4 jet fighter, designing the nose cone of the MX missle, and calculating the wave drag of ship hulls. Currently, he is working on two projects which involve the study of aerodynamics for hypersonic aircraft and space vehicles.

One of Yen's goals is to become involved with more students working toward their Ph.D.'s. He has revived research in rarefied gas dynamics with applications toward a space vehicle program, and established new research in hypersonic flow programs to apply technology from missles toward airplanes.

For 32 years, Yen has generally taught graduate students. He likes teaching and working with students because he finds it an interesting challenge. Professor Yen believes, "What makes life worth living is that you learn something new every day."

Andrew Martens



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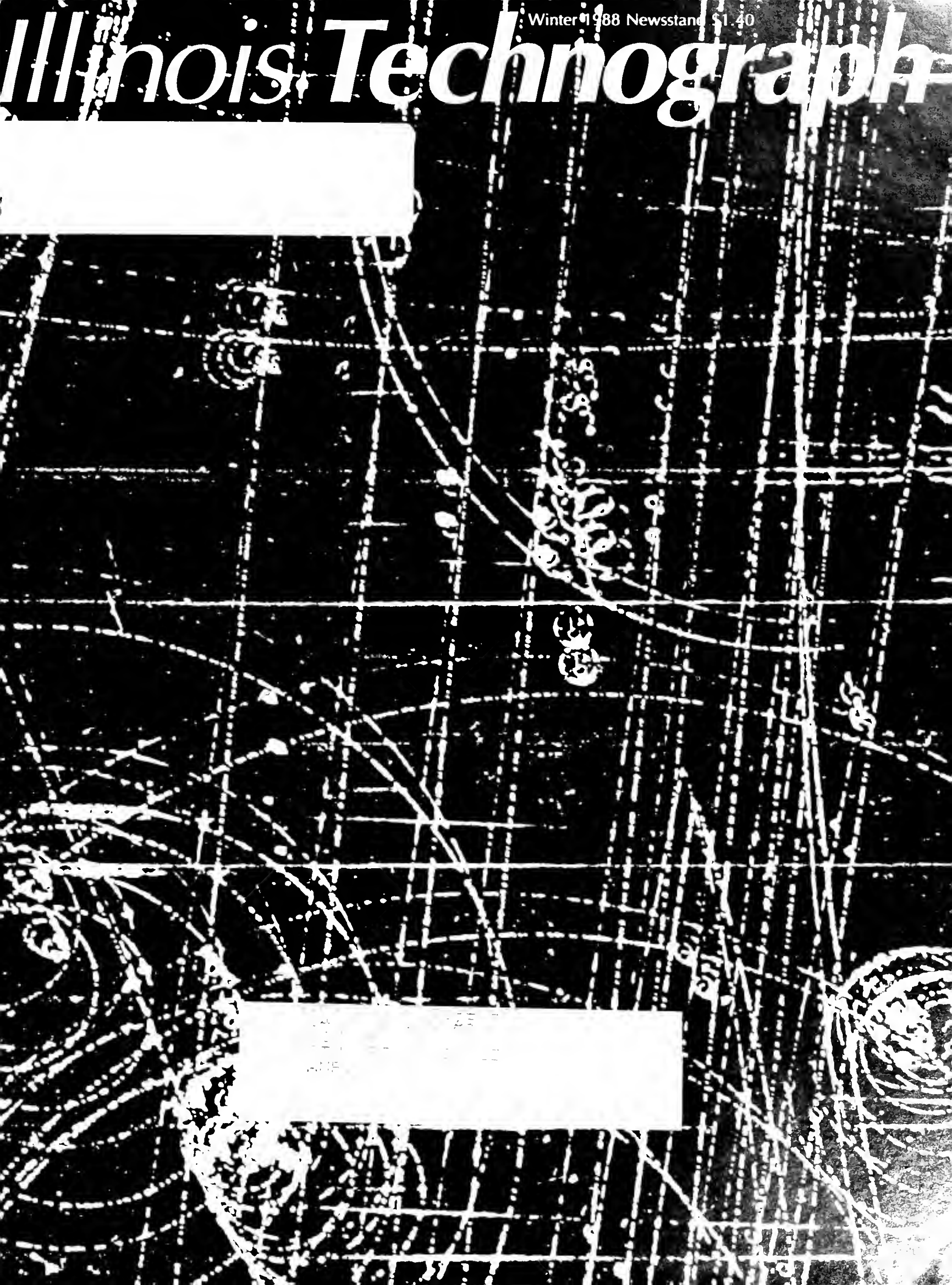

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To Be or Not To Be Involved

Being an engineer at Illinois is certainly no simple feat. You wake up around eight o'clock for your eight o'clock because you stayed up doing homework until 2 A.M. the night before. You skip breakfast and go to class until noon. Grab a burger and run because you don't have time to go all the way back home. Go to class until 5 P.M. Go home. Eat. Rest for fifteen minutes, but don't waste too much time because you have to stay up until 2 A.M. (otherwise your schedule wouldn't be complete).

Imagine spending four years or more like this as some engineers do. You graduate with a very impressive, technical degree and attractive transcripts. But, to put it bluntly, you're little more than an overeducated recluse. Do you have any social skills? Can you function with other people from different backgrounds? How will you talk to your firm's clients? How realistic are your perceptions of engineering and of the world?

Today's engineer should more than ever be a broad minded, diversified individual who can effectively communicate and interact with others. Most of today's engineering positions require a team approach for which social and leadership skills are an absolute neccesity. Unfortunately, following a college career of a purely academic nature circumvents these essentials.

The solution, which you've probably heard before, is to GET INVOLVED. In an engineering school of this size, let alone a campus of this size, there is a plethora of activities to become involved in. I know. You're going to ask, when am I going to have the time with all my homework? This is a fair question, but I have to ask you, why it is that many other engineers can perform well in school as well as actively participate in extracurricular activities? They aren't any smarter than you, nor do they have a lighter course load than you. Is it that they've learned to budget their time more wisely and to discipline themselves to be able to juggle " a million different things " at one time? Chances are that the answer is simple: they can and you can't. If so, learn to use your time more efficiently. Otherwise that company's reason for not hiring you might be because " they can and you can't."

In our previous issue, we listed several engineering and engineering related clubs on campus. This time I would specifically like to focus on Engineering Council, which offers a wide range of activities for students.

There is the Engineering Speakers Bureau (ESB), which links engineering students here at the university with high school and community college students across the state. Students who participate in ESB gain valuable speaking and presentation experience.

Student Introduction to Engineering (SITE), is a two-day program held in February and introduces graduating high school seniors to the College of Engineering. The program includes guest speakers, a banquet, design competitions, and departmental tours. Engineering students may serve as hosts or as guides, building their social skills in the process.

Engineering Freshmen Committee (EFC) provides essential information about the first year of college life and about the various majors in engineering. EFC meetings feature speakers discussing many helpful topics such as how to: study and prepare for tests, apply for student and financial aid, find a job, and get involved in engineering student activities. EFC also organizes social events to give freshmen the opportunity to meet new people and get away from the books for a while.

The Knights of St. Patrick Selection Committee selects the recipients of the highest nonacademic award offered by the college. Each year, twelve to sixteen students who have been nominated by their societies, departments, and deans, are selected based on their leadership and service to the college and University.

The Dean's Student Advisory Committee (DSAC) serves as a liason between the deans of the College of Engineering and the students. DSAC also initiates new programs that benefit all engineering students. Engineering campus leaders benefit from DSAC by using it as a source of information concerning current student opinions. Ten to thirteen students serve on DSAC and are chosen toward the end of the spring semester to serve the following year.

Engineering Council Awards Committee is responsible for publicizing, tendering nominations and applications, interviewing, and making the final decision on awards such as the Everitt Award and the Pierce Award.

To make participating in Engineering Council even more enjoyable, the Social Affairs Committee sponsers events such as St. Pat's Ball, volleyball and bowling tournaments, pizza parties, and blood drives.

Being a successful engineer takes more than just a degree. Along the way, you must take advantage of the many opportunities available to you. Engineering Council is one such example, but the list is endless. In order to make it in the rat race, to live life in the fast lane, to get that edge over other engineers, GET INVOLVED.

Kiefer K. Mayenkar

Illinois Technograph invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions are also welcome. Letters must be signed, but names will be withheld on request.

The Fifth Force

University of Illinois physics professor Steven Errede slashes his blue marker across a page like a child with a crayon. The young man sits on the edge of his chair, rips out sheets of paper and scribbles blue formulas, webs of vectors and words like "quarks", "gluons" and "gravitons." Errede pushes his hair back and stares at the bleeding page. "There's something beautiful going on here, but I don't understand it," he says. "We're too dumb to figure it out."

Errede is one of more than a hundred scientists in the United States testing a new theory: Newton's law of gravitation may be wrong. A "fifth force" may exist in nature. So far, physicists have identified four forces in nature: gravity, electromagnetism, a strong nuclear force and a weak nuclear force. Gravity, defined as the universal force of attraction between all matter, is the weakest of the four forces. It is also the least understood.

During the past few months, scientists have been finding data that appears to violate Newton's law of gravity that the attraction between two bodies is proportional to the size of their masses and inversely proportional to the distance between them.

Errede says if a previous unknown fifth force exists in the universe, it must be extremely weak. "The fact that we don't get sucked into the walls is a good indication of that," he says with a laugh. He says people hypothesize the force works only for a short distance and then loses its grip exponentially as the distance between the two masses increases. The range may be only a few thousand feet.

To help people visualize the properties of the weak fifth force, Errede says, "Pretend God decided to make the fifth force a very strong one on this planet."

Imagine being so light on the surface of the Earth that you float down the street. You grab on to trees, pull yourself into a building and hover in the elevator. As the elevator goes up, you become heavier and your feet sink to the floor. After you reach a certain height above ground, you weigh as much as you do today. You can take the elevator down again and become lighter as you hit ground floor. But as you ride down to the basement, you grow heavier again and attain your full weight. This is an example of the repulsive force, which pushes you away from the surface of the Earth.

If the fifth force is attractive, it will pull you towards the surface. Picture yourself weighing twice as much as you do now and losing weight as you go up or down on the elevator, losing until you reach your normal weight. "The force is like a fog that surrounds the Earth," Errede says. "It is denser on the surface, but the higher or lower you go, the more it fades."

On one January evening in 1986, Errede and three other physics scientists went into Loomis Laboratory "at the dead of night" and made almost 200 gravity measurements. Errede, professor Leland Holloway, postdoctorate Sampa Shadra and graduate student Hovhannes Keutelian worked from midnight to six in the morning. They rode up and down the elevators in the four-story building, carrying a small electric scale and other equipment from floor to floor. "The janitors got mad and tried to kick us out of Loomis," Errede said.

Errede repeated the experiment a few days later in the Century 21 building in Champaign, Ill., and then in University Inn. He says that, to his delight, the data seemed to show violations of Newton's inverse square law of gravity.

Physicist Steven Errede, proponent of the fifth force theory uses a specially designed electronic scale to measure the mysterious force.
Photo by Dan Powers.

Errede's next stop was the John Hancock Building in Chicago, on January 16, 1986. The four scientists were escorted by a guard as they prowled the building after midnight, measuring gravity, air pressure, temperature, line voltages, magnetic fields and the stability of the entire system. "Objects were heavier in Chicago than in Champaign-Urbana," Errede says. "We thought we broke the scale on the way there." Errede never published his results. He forgot there was an "anomaly" in Chicago that could affect their measurements. "Lake Michigan," Errede says. "It's so massive it could have a powerful effect on gravity. So we couldn't publish the paper."

Errede's methods of testing the fifth force drew both criticism and praise.

Mark Ander, a geophysicist at Los Alamos National Laboratory, credited Errede and Holloway with "reinventing the wheel." "They just can't jump into a field without proving that they know what they're doing," Ander said. "I don't think they realize they have to compile a tremendous amount of data--about the cellars, walls and other buildings." Ander recently finished gravitation experiments done on a hole drilling into the ice in Greenland.

Ephraim Fischbach, a physics professor at Purdue University, said: "I encourage Errede to continue with the experiments. In principle, everything will have an effect on their measurements. They should make enough measurements to solve the problem. It's not necessarily a sloppy experiment. It's hard to say." Fischbach sparked worldwide interest in the fifth force problem with a paper he published two years ago.

Errede says he is designing better instruments to measure gravity. He displays the inexpensive equipment he used in his fifth force studies. The electronic scale looks like a small record player encased in glass and glued on top of a keyboard. The weight is placed on what looks like the turntable. The scale slides under a protective magnetic shield, a grey sheet that bends to form a tunnel. The cables, a tangle of rainbow garter snakes, link the machines together for multiple measurements. The equipment can be hooked up to a computer.

As he talks, his eyes drift toward the computer screen on his desk. His fingers keep itching toward the keys. "Sorry that I keep playing with this computer," Errede says, "but I'm really excited...we might be on the edge of discovering a new particle in the universe!"

Iris Chang

Solar Energy: A Light in the Dark

During the oil shortage of the 1970's the realization that fossil fuels are neither inexhaustable nor forever economical caused a widespread search for alternative power sources. Much was said at that time about solar energy and its possibilities, but now discussion seems to have diminished. Does this mean solar energy has failed? Probably not, but the urgency of obtaining a new energy source has been removed. There is no longer a shortage of oil and the government has thus halted funding on major solar research projects that were started during the crisis.

Many today are not as concerned about the availability of fossil fuels as they are worried about the fuels' impact on the environment. Last summer's record temperatures in much of the country led to increased discussion about the greenhouse effect. Increasing concentrations of carbon dioxide in the atmosphere due to combustion of fossil fuels are acting as an insulator to the earth, not allowing heat to radiate back to space and thus raising the temperature of the earth. Sulfur dioxide by-products from factories lead to acid rain in both the United States and Canada, destroying forests and contaminating lakes. These are problems that are appearing after only a short period of widescale fossil fuel use in the world.

If the situation continues to deteriorate, solar energy may be a more attractive energy alternative whether fossil fuels are available or not. Solar energy causes none of the environmental problems associated with other forms of energy. Furthermore, the supply is inexhaustable.

Common to all applications of solar energy is the search for more efficient ways of capturing light energy. There are two primary types of photovoltaic cells used to do this. The traditional material used in photovoltaic cells is crystalline silicon, similar to that used in semiconductor chips. This is currently the more efficient type of cell, converting up to thirteen percent of the sun's energy. The other type of cells being investigated is based on thin films of amorphous silicon alloys. Because these lack crystalline structure they are much more inexpensive to manufacture.

Stacked amorphous thin films allow greater conversion of light energy by splitting the sunlight into multiple band gaps. The top stacks are manufactured to absorb the higher-energy green and blue light while the lower-energy, longer-wavelength red light passes through and is absorbed by the bottom stacks. This not only allows for more light to be absorbed but prevents performance degradation that single thin layers suffer when used alone. New techniques that increase efficiency in energy conversion are sure to be discovered. This will be an important factor in determining the future role of solar energy as a major power source.

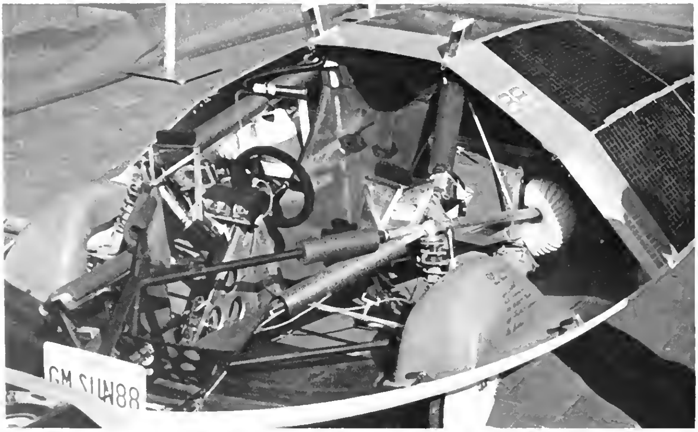
The largest use of solar panels today is in the handheld calculator business. Watches, portable stereos, and photographic light meters also employ solar power. The market for devices such as these grew from near zero in 1979 to more than $80 million by 1983. The role of solar panels in electronic devices will increase in the future as consumers discover their economy and convenience over batteries and power cords.

Since solar power is not economically profitable, and because power generation and distribution systems are already established in industrialized nations, third world countries and remote areas stand the best chance for solar power networks to be set up. Diesel generators and batteries are currently being used in remote areas where establishing power lines is infeasible. Solar panels are already developed to the point that they provide less expensive, lower maintenance electricity than these sources. In Thailand ten 500 watt arrays have already been installed to give remote villages central power sources.

Serving the needs of the United States, however, would require more advanced technologies. During the oil crisis the country looked toward space as the answer, proposing to build huge satellites composed of photovoltaic plates. Energy would be converted to microwaves which would be beamed to a receptor on earth.

(continued on page 8)

The GM Sunraycer is one of the marvels made possible by solar technology. Pictured with the Sunraycer, opposite, are GM representatives Victor Rios, and Sandy and Richard McKenney. Photos by Chris Guy.



GM SUNRAYCER

Dimensions:19 7 feet long; 6.6 feet wide, 3.3 feet high.
Weight: 390 pounds, Gross weight with driver: 573 pounds.
Speed: Averaged 41 6 mph during 44 9 driving hours over 1,950 -mile race.
Construction: Aluminum tube spaceframe chasis, body of composite sandwich materials
Solar array: 90 square feet; designed and built by Hughes Aircraft; same type cells as used in satellites.

Motor: 3 kw,4 hp Magnequench brushless DC, weighs 11 pounds and was developed by the GM Research Laboratories Magnequench magnets were manufactured by GM's Delco Remy Division.
GM Sunraycer represents the development and demonstration of advanced technology as applied in aerodynamic design, lightweight structures and materials, high-efficiency batteries, lightweight electric motors, lightweight suspension,and steering systems, and high-efficiency solar arrays and power electronics.

The energy system envisioned was called the Solar Power System (SPS). Satellites the size of Manhattan were foreseen. NASA and the Department of Energy completed extensive studies in the late 1970's and concluded that the project was technically feasible, economically viable, and marketable. Solar satellites would be able to gather and transmit energy night and day, regardless of weather conditions on earth. They would also be inexpensive to maintain, and just one satellite could supply the electrical needs of an entire city. NASA and DOE asked the National Research Council to study their findings. NRC agreed that SPS was technically feasible, but decided that there would be more practical alternatives available in the United States. The NRC report led to the abandonment of SPS.

There is no question that SPS would have required vast amounts of money to develop. Large, lightweight photovoltaic cells would be needed. Transporting the plates would pose a formidable problem. A space transport system much larger than the space shuttle would be needed; even then, approximately 190 flights would be necessary to construct one satellite.

The Soviets have reportedly decided to pursue development of a similar system by planning a $200 billion SPS program of their own. However, the level of Soviet development is controversial. David Webb, a member of the National Commission on Space, believes that the Soviets are twenty years ahead and plan to use satellites to transmit energy to earth by 2010. Marcia Smith, a member of the United States Congressional Research Service, disagrees. She believes that Soviet development is in the same beginning stage of research as the United States.

Solar power does not have to provide all of our power needs alone. It can be an effective, inexpensive auxiliary power source which would reduce the amount of fossil fuels consumed. Solar power will not become a major power source soon. However, this does not mean research should not be pushed. Work is being done around the world, and progress is being made in making solar power a practical energy alternative.

Thomas Chuang

1. From what nine letter word can you remove one letter at a time and eventually get a one letter word?
2. What catastrophy could put astronomers out of a job?
3. How can six toothpicks be arranged to form four exact equilateral triangles (with no toothpicks broken)?
4. How much heat must be removed from the earth's surface to freeze the water on the surface to a one meter deep layer of ice?
5. Can you change SOFT to WARE by changing one letter at a time in four moves?
6. To reach a destination sixty miles away on time, you must average sixty miles per hour. During the first half, you have car problems and average thirty miles per hour. What must your speed be on the second half to make up for this slow beginning?

Dean Wagner

(techteaser answers on page 13)

Vitamins vs. Pollution

University of Illinois chemist Richard Larson has found a new way to clean up polluted waters--feed them vitamins.

Larson, a professor of environmental chemistry, said Vitamin B2 can be used to soak up sunlight or lamplight and transfer this energy to other compounds, sparking a chemical reaction.

When riboflavin (vitamin B) picks up light energy, it rises to a more excited state and becomes more reactive, Larson said. The energy can then be transferred to compounds which activate a reaction to decompose unwanted chemicals.

Riboflavin works very well for the disposing of compounds like phenol and aniline. Phenol is found in contaminated water and is used to make pesticide; aniline is used for herbicide. Methylene blue and rose bengal, synthetic dyes, can also be used, but Larson said he does not know how safe it would be to put the dyes in water.

"Riboflavin is a vitamin, so it's probably not harmful," Larson said. "It is found in every living cell." Riboflavin is already present in water, so adding the vitamin would simply be increasing the amount already there. Riboflavin also degrades over time.

Larson has conducted test tube experiments with riboflavin for the past two years. In a few months, he will test the vitamin in groundwater polluted with coal, tar and other waste. The groundwater will come from an abandoned coal plant near Taylorville, Ill.

Larson said his research "shows promise" for using vitamin B in conjunction with another chemical to clean up hazardous waste. When water enters a sewage plant, it is cleaned up before it is poured back into the rivers. "We want to get it to the point where the river and other natural processes can take care of it," Larson said.

Joseph Elliot

Fusion Technology

University of Illinois researchers are working on fusion reactors that produce very little or no radiation.

George Miley, Professor of Nuclear Engineering, and Winfried Kernbichler, Assistant Professor of Physics, are trying to find a way to reduce the neutron production from fusion reactors. Conventional fission reactors split the atomic nucleus to produce energy; fusion reactors combine lighter atomic nuclei to get energy, Kernbichler said. Both fission and fusion produce radioactive neutrons.

Scientists at the U. of I. are studying "aneutronic" reactors. Today's fusion reactors use deuterium and tritium to produce neutrons, alpha particles and some energy. Aneutronic fusion reactors may use nonradioactive deuterium and helium-3 to produce protons, alpha particles and very few neutrons.

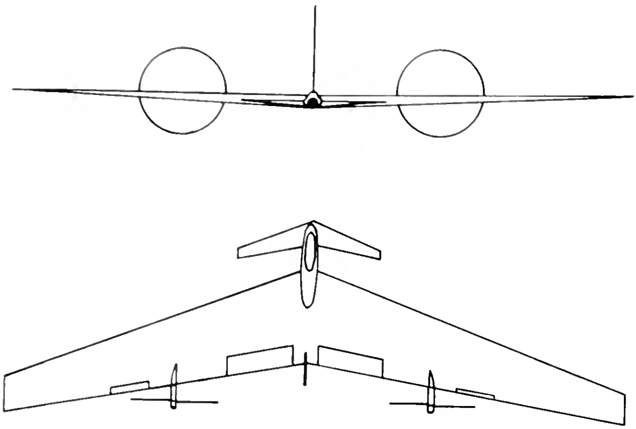
The problem is, there is not much helium-3 on Earth. "There is lots and lots of it on Jupiter and the moon," Kernbichler said. He noted that one professor at the University of Wisconsin believes there may be more helium-3 deep under the Earth's surface. Miley spoke of the possibility of mining the moon for the helium and creating space filling stations on the moon and Jupiter for fusion fuel.

It is also possible to use hydrogen and boron-11 to fuel the fusion reactions, Kernbichler said. Both fuels are plentiful on this planet. However, extremely high temperatures would be required to ignite the fuels. Just to start a conventional fusion reaction, a temperature of 200 million degrees Fahrenheit is needed. It would have to be about five times as hot for deuterium and helium-3. To ignite hydrogen and boron-11, the temperature would have to be more than 50 times greater.

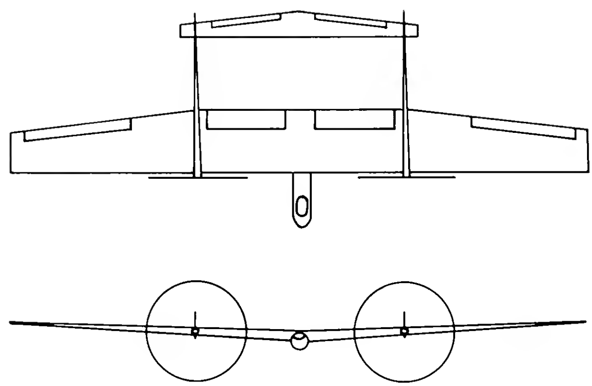
"Even conventional fusion requires such high temperatures, walls would not stand it," Kernbichler said. Scientists use magnetic fields to confine the reactions.

Kernbichler said that Japan and some countries in Europe are actively working on aneutronic reactor research. In Illinois, scientists are working primarily on the theoretical side of aneutronic research.

Minako Hashimoto



Drawing of proposed designs of the Marsplane by Brian Switzer.



Preparing for Mars...

As the United States considers exploring space, engineers are working to make such a grand idea possible. The hardest problem engineers encounter is not finding solutions to technical problems, so much as finding the funding to support research. In 1986, the National Commission on Space anticipated a manned outpost on Mars by 2017 and a space station with full-scale manufacturing capacity by 2027. The commission further assumed the existence of an operational space station by 1995, and estimated the total long-range costs at $700 billion. Attainment of those goals is contingent upon availability of these funds. Even though this amounts to less than two cents a day for every person in the United States, engineers feel there is no way to obtain such funds. Technology has outgrown funding in the United States space program. In spite of the logistical difficulties in creating a space station on Mars in the near future, some engineers have already taken a space station for granted in their work.

Before such a station could be built, Mars would have to be explored further. To do this, students at the University of Illinois have begun developing the technology to investigate the planet's surface. Last Spring, aerospace engineering students in Aeronautical and Astronautical Engineering 241 (Aerospace Vehicle Design), researched the use of a special lightweight airplane to survey Mars. The research was undertaken as a part of a program developed by NASA/USRA (Universities Space Research Association) to allow university students to investigate various aspects of space technology. Professor Kenneth Sivier and graduate student Michael Lembeck guided students in the design of a Marsplane and a spacecraft to carry the plane to the surface of Mars. The University of Illinois was coordinated with the Marshall Space Flight Center in Huntsville, Alabama, to provide access to information and guidance for the project.

The plane would fly in the thin Martian atmosphere, which is mostly carbon dioxide and has an atmospheric pressure of about one percent that of Earth. The Marsplane concept was initially studied in the late 1970's by NASA's Jet Propulsion Laboratory. The studies demonstrated that a vehicle flying in the Martian atmosphere had the capability to carry out useful exploratory missions.

High-altitude airplanes such as those proposed tend to possess two common characteristics; large wing spans and propeller propulsion systems. Students researched various power sources, such as solar power, fuel cells, and storage batteries. Different possible combinations of power, engines and aircraft shapes were considered in their designs.

The undergraduates used a prototype expert system developed by Lembeck called MIND, Mechanically INtelligent Designer. The artificial intelligence of MIND proposes a conceptual design based on the algorithm developed by the user. According to Lembeck, this is "learning by teaching". NASA headquarters uses MIND to develop strategic plans for the 1990's and beyond.

The American Institute of Aeronautics and Astronautics (AIAA) sponsors an annual student design competition funded by Allied Corporation, in which teams of three to ten students have one year to create a spacecraft design. Students in Aeronautical and Astronautical Engineering who elect to enter this competition fulfill their senior year AAE 241 requirement. Already, a team of ten senior design students are participating in a project akin to an "America's Cup" in space. This spring, the senior design project in AAE will be the design of a "solar sail".

Classes and competitions can encourage aspiring engineers a great deal, but these can only continue while there is money invested in research and discovery. There seems no limit to the creativity and ingenuity of Man's reach for the stars; he is bound to Earth only by his limited resources.

Deborah Zandell

Photo by Ken Horlander.

David Claude O'Bryant is an Associate Professor of General Engineering. Although he has been teaching engineering graphics for more than 30 years, he calls himself an administrator and not an artist.

O'Bryant grew up on a farm in Bryant, Ill. He said he wanted to be an engineer ever since he was four years old. People would ask him, "You want to drive trains?"

"No," he would say, "build highways, design things." Indeed, he has spent most of his life building things--having started with Erector sets and Tinker Toys.

O'Bryant said he always wanted to go to the University of Illinois. He majored in mechanical engineering at the U. of I. and received his bachelor's degree in 1958. He earned a master's of science in mechanical engineering in 1961, and then a doctorate in education in 1970.

Although his training was in mechanical engineering, O'Bryant's career switched tracks and raced into graphics. When O'Bryant was an undergraduate at the University of Illinois, he noticed that pledges in his fraternity (Acacia) went to him for help in engineering graphics.

"I thought, gee, maybe I can get someone to pay me for this," O'Bryant said. As it turned out, the university needed more instructors of engineering graphics at that time. O'Bryant became an undergraduate teaching assistant in engineering drawing. Aside from some earlier summer jobs at Western Electric and International Harvester, O'Bryant has been teaching engineering graphics for 31 years.

He watched engineering graphics evolve from "T-square and triangle to AutoCAD." He said graphics technology has shot up exponentially, with most of the dramatic advances made within the last four years.

O'Bryant said when he isn't teaching engineering graphics, he's shuffling papers. Some of this has resulted in the Minority Introduction To Engineering program (MITE). O'Bryant was one of its founders in 1969. Although MITE started at the U. of I., it branched out and became national in 1974. Today, MITE is active in almost 50 universities, helping over 2,000 new students a year. MITE focuses on groups underrepresented in engineering, such as blacks, Hispanics and American Indians. During the summer, MITE exposes them to what engineering is all about and demonstrates how their high school math skills can be applied to engineering.

Said O'Bryant, "We would like to think the increase of minority students in engineering is attributable to our program."

Stephen Clark

1. STARTLING
STARTING
STARING
STRING
STING
SING
SIN
IN
I

2. No more stars (an anagram for astronomers).

3. Form a three dimensional prism.

4. 8.758EE15 Joules (1 m of ice 1.087 m water).

5. SOFT
SORT
SORE
WORE
WARE

6. There is no way to reach sixty miles. To go thirty miles, you have to had travelled for one hour, which must be your travelling time for the entire trip.

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International Perspective

From The Wall Street Journal, Monday, February 27, 1989:

" The next century's corporate chief must have a multienvironment, multicountry, multifunctional, maybe even multi-company, multi-industry experience."
-Ed Dunn, Corporate Vice President Whirlpool Corporation.

" Global, global, global, " is how Noel Tichy, a professor at University of Michigan's graduate school of business describes the wider-ranging chief executive of the future.

" With over half of Arthur Andersen & Co.'s revenue generated outside the U.S., the company's next chief executive will be a person with experience outside the borders of the U.S...."
-Duane R. Kullberg, Partner Arthur Andersen & Co.

A great deal of foresight is not necessary to conclude that corporate success in the future will very much be related to the international experience posessed by a particular individual or firm. Even today, many growing businesses are realizing that their continued prosperity is dependent on their ability to adapt to a world market.

We are now on the forefront of a new age in business and the American ignorance of foreign cultures is no longer acceptable. As great American companies such as Arthur Andersen & Co., Caterpillar, and IBM (to name only a few) expand both nationally and internationally, the extent of international exposure of their employees is critical to their survival and success in foreign lands.

Unfortunately, American education in general fails to take into account the great importance of an international education. Some high schools require a semester or two of a foreign language. Engineering majors at most universities are not even required to take any sort of international education class, let alone one in a foreign language.

Unfortunate also is the fact that here at the University of Illinois, students and specifically engineers, have ample opportunity to take advantage of the growing trend of globalization but rarely do so. Foreign languages and cultural courses are only the beginning. The university also offers a wide range of international education programs that are intended exactly for the purpose of providing international experience to students.

UIUC is the only college in the U.S. offering an International Minor in Engineering as part of a regular degree program. A major in mechanical engineering may have a minor in Far Eastern Studies, an Electrical engineer may have a minor in Latin American studies and so on. The minor requires 21 semester hours of cultural and language studies in the area of concentration. The student must also spend eight weeks working or studying in the geographical area of concentration.

The Summer Opportunity in China Program was developed to introduce students to Chinese culture and to give them a reasonable proficiency in the Chinese language. Students participating in the program complete an intensive Chinese language course on campus in the spring, which is then followed by six weeks at a Chinese university and two additional weeks touring China.

The college has an exchange program with the Technische Universitat Munchen in Munich and Technische Hochschule in Darmstadt, West Germany. Eligibility requirements include completion of university-level German and an outstanding academic record.

UIUC currently has exchange agreements with three universities in France: L'Ecole Nationale des Ponts et Chaussees in Paris, L'Institut Nationale Polytechnique de Lorraine, and Univerite de Technologie de Compiegne. Interested students should be juniors or seniors.

The Colombian summer program is arranged through the Universidad de los Andes in Bogota. Students work part-time in Colombian industry for nine weeks, which includes two weeks of travel through Colombia and South America.

An exchange program is available for students in ceramic engineering to study for one year at the Universidade de Aveiro in Portugal. Students should be juniors with some knowledge of Portuguese.

The college works with Yonsei University in Seoul, Korea to involve students in work-study programs. The primary goals are to have students learn Korean through intensive language study and gain work experience.

Additional information on these and other programs is available at 207 Engineering Hall.

Although the future is seldom clear in the volatile world of business, the fact that globalization will be important in the nineties and in the coming century is definite. Students at the University of Illinois have the opportunity to become a part of this future. The choice is clear. ■

K K Mayenkar

Kiefer K. Mayenkar

Illinois Technograph invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions are also welcome. Letters must be signed, but names will be withheld on request

The Septillion Ton String

I remember as a little boy staying outside at night looking at the stars in the night sky and wondering why they were in such random positions. I later learned that stars were really only components of a much larger object, a galaxy. Galaxies, like stars, also seem to be distributed at random. Or are they? For many years, scientists have searched for the reason that galaxies are distributed as they are. Now they may have found one: theoretical entities, called cosmic strings. These are superthin, supermassive strands which were created a fraction of a second after the Big Bang.

A little over twelve years ago, T.W.B. Kibble, from the Imperial College in London, concocted the concept of cosmic strings. The response to his paper on the strings was, however, a little lackluster. For five years the subject lay dormant until Yakov B. Zel'dovich, a Soviet physicist, realized that cosmic strings could explain galactic distribution. Currently the theory of cosmic strings is flourishing as the theory of black holes did in the 1960's. With a little anticipation, the cosmic string theory might become as well known and as reputable as the current black hole theory.

Anyone who has had a basic science course is familiar with the event known as the Big Bang. The universe was created by the Big Bang and has continued its outward expansion for some 15 billion years. However, the most interesting time frame to study is within the first seconds after the Big Bang. During that time, there existed a very high energy vacuum. As the universe began to expand, its unified force separated into the four known forces (electromagnetic, gravitational, strong and weak nuclear force). It also underwent several phase transitions referred to as the "breaking of symmetry." This is comparable to the common phase transition of water to ice. No one actually knows how many phase transitions took place at the time of the Big Bang, but it is believed that they all occurred before the universe was 1EE—35 seconds old. These phase transitions caused the "defects" that occur within the equations that model our universe.

Astrophysicists such as Albert Einstein created equations to describe the creation and expansion of our universe to a reasonable degree. These equations give the first support for the theory of cosmic strings. The solutions to these equations gave rise to three types of defects: domain walls, monopoles, and cosmic strings. In our universe, we might have any combination of these defects.

These defects can be thought of as "flaws" in the fabric of space. Occasionally, when water freezes, air bubbles become trapped in the ice. These air bubbles are analagous to the flaws that might occur in space. The first two theoretical defects, domain walls and monopoles, do not fit with what is observed in the universe today. Cosmic strings are the most likely of the three theoretical defects because of their subtle effect on the universe.

To imagine a cosmic string, visualize a very thin wire with infinite length that can turn, twist, coil or form loops on itself. Cosmic strings are said to be infinitely long and to span the entire universe. Strings do not have to exist only as straight or twisted strands, but can also exist as coils or separate closed loops. The thickness of the string is suspected to be about 1EE-32 meters in diameter. That means that 3.7EE22 cosmic strings could fit within the radius of a hydrogen atom. Trapped within a cosmic string are the initial vacuum conditions of the Big Bang. The four forces have not yet separated from the unified force. This vacuum is what keeps the string extremely thin. The strings with the most symmetric vacuums (the fewest phase transitions) are the thinnest. The vacuum also causes the string to be extremely massive. A string approximately 16 kilometers long would have the same mass as the Earth.

Newton concluded many years ago that mass is the main component of gravity. As mass increases, so does its gravitational force. A cosmic string, with its extreme mass, can actually bend the space surrounding it. This can be proven by Einstein's Theory of General Relativity. If a cosmic string were to pass between two objects at rest, it would set the two objects in motion towards each other at 60,000 meters per second. In the bending of space, the string forms space into a cone around it (diagram 1). A similar idea is the bending of light near the string. As was proven some time ago, light can bend in the presence of a very massive object. If the cosmic string were to pass between pulses of light instead, the light would be bent as the string passed. This causes what is known as a gravitational lens (diagram 2). If the conditions are just right, two images of the same object can be seen. One of the images is a false image, and the true object is not in the position it appears to be.

Galactic formation and distribution is the most interesting part of this theory. Wave theory says that the tension of a string is directly related to its mass per unit length. This gives the cosmic strings a very high tension and makes them prone to oscillations. Loops of cosmic strings oscillate and radiate gravitational waves. This causes matter in the universe to migrate toward an oscillating loop. Larger loops attract smaller loops; in turn, the smaller loops attract more matter. This could pull matter into galaxies, and galaxies into clusters.

(continued on page four)

(continued from page 3)

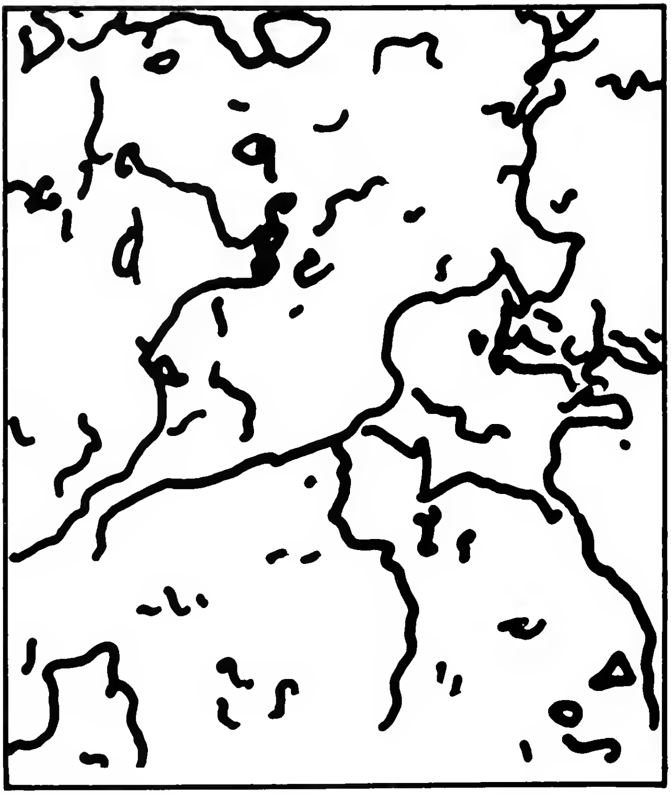
In 1985, Neil Turok, from the Imperial College in London, linked his simulations of string behavior to galactic cluster distribution. Suprisingly, this was an accurate comparison. Many other calculations have been performed to verify that a cosmic string, or more likely, a network of cosmic strings could match theory to reality.

Besides the huge clumps of matter in the universe, there are huge areas that contain no matter. To explain these huge voids, Ed Whitten of the Institute of Advanced Study at Princeton University suggested that the strings might be superconducting. His colleague, Jeremiah Ostriker, then idealized how the voids might have been formed.

The string can have the property of superconductivity because, under the conditions of the Big Bang (contained in the string), electrons have no mass and can zip along the string without any resistance. This superconductivity would cause very powerful electromagnetic fields. These fields propagate away from the string and expand, creating heat. As the heat builds up, the pressure increases, and a "bubble" of gas expands to create a void. The theory of superconducting strings describes matter that is pushed away from the expanding "bubble," contrary to the theory of gravitational waves, which attract matter to the string.

If cosmic strings indeed exist, there is still a problem of detecting them. The gravitational lens might be one method. Astronomers can calculate the mass of an object required to produce a gravitational lens by the amount of separation that exists between the two images. Cosmic strings could explain previously encountered double-imaged quasars which require an unseen object between us and the object to have a mass equivalent to a cluster of galaxies. Also, as cosmic strings move through the universe, the temperature of the gas surrounding the string will change. The gas in front of the string would be cooler than the gas behind it. With this, scientists might be able to detect strings by their motion. Several phenomena have now been located that fit the description of cosmic strings in the center of the Milky Way Galaxy. If these objects move as expected, we may have a more solid basis for the cosmic string theory. ■

By Jack Gidding



Above is a rendering of possible configurations of cosmic strings in the abyss of outer space. Of infinite mass and infinitesimal thickness, these remnants from the big bang may hold the answers to the beginning of the universe.

Drawing by Brian Switzer

The Eagle Has Landed

After nearly two years of planning, the EAGLE initiative was announced at a national conference in Arlington, Virginia, on February 13, 1989. EAGLE, the Engineering Alliance for Global Education, will be an internship project involving several leading engineering colleges, in addition to American and Far Eastern companies. The Engineering College at the University of Illinois played a leading part in the creation of EAGLE. EAGLE will take a group of engineering and science students and provide language training in either Korean, Chinese or Japanese. When the language training is completed, the students will receive a year-long EAGLE internship with a company in Korea, China or Japan.

EAGLE was brought about by the growing economic emergence of the "Pacific Rim" nations; Japan, China and South Korea. Presently, the general public, especially the technical sector of the American society, is woefully ignorant of the Far Eastern culture, language, and technical achievements. Already, the Asian advantage can be seen in everything from Hyundai cars (South Korea) to Sony Compact Disc Players (Japan).

For the United States to continue to produce quality goods at competitive prices, we must be aware of Asian progress. Recently, American business leaders have been learning about the manangerial techniques of Oriental businesses, specifically Japanese. This trend has been brought about by current books such as Theory Z. The EAGLE project is geared towards the technical side of the Pacific Rim phenomena; it will provide experience for a pool of young engineers to learn and communicate with their Asian counterparts.

Specifically, the EAGLE member schools will consist of eleven 'alliance' universities with strong engineering programs: SUNY-Buffalo, Lehigh, Cornell University, the Georgia Institute of Technology, University of Texas at Austin, Texas A&M, Rose Hulman, University of Wisconsin, North Carolina State, University of California at Berkeley, and the University of Illinois at Urbana—Champaign. Corporations from the United States as well as from the Pacific Rim will also be involved as host companies for the interns. This is the largest single internship project to date to involve universities and businesses in the Far East. The importance of the project is illustrated by the funding of approximately $5,460,000 yearly, with the majority of financing coming from the National Science Foundation and grants from private companies.

The EAGLE Initiative itself will consist of 250 science and engineering students in a two phase program. The first phase is a language program for the students, while phase two is the actual internship. The students, selected in their sophomore year, will undergo a rigorous foreign language sequence consisting of a five hour class during both semesters of their junior year. With every word having a corresponding character, Oriental alphabets are notoriously difficult to learn, and as students need to learn quickly how to verbally communicate, the emphasis of the class will be on the spoken language.

During the summer after junior year, EAGLE participants will become involved in an "immersive" study of the language, in which they will hone their language skills. Phase one ends upon completion of the summer session.

Assistant to the Dean David J. Jones

Phase two, which will begin nearly two years after the students have been selected as EAGLE participants, will be an 8-12 month internship for a company located along the Pacific Rim. During this time, classes will be scheduled so that interns can continue to refine their language skills.

The EAGLE initiative is a unique opportunity for today's engineering student to learn engineering from a different perspective and to live in a foreign culture. Students interested in the EAGLE Program or any International Studies program should contact David Jones, 207 Engineering Hall.

This article was based on an interview with David Jones, Assistant to the Dean, and the College of Engineering document "Project Proposals for the Establishment of a U.S. International Engineering Program - An EAGLE Initiative". ■

By Mike Grimm

Photography by Dan Powers

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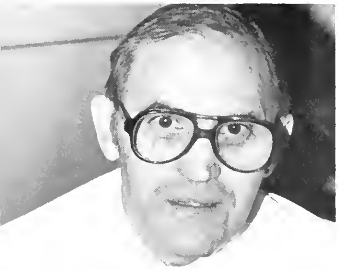

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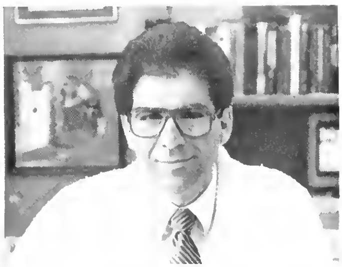
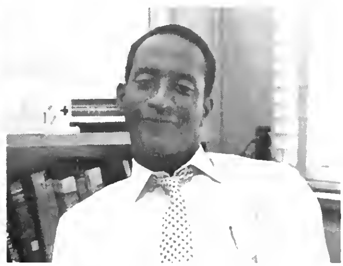


Assistant to the Dean Thomas E. Glenn



Assistant to the Dean William E. Harris

Assoc. Dean/Placement Robert J. Mosberg

Asst. to the Dean Jonne Brown

Presenting the Deans of the College of Engineering at the University of Illinois at Urbana-Champaign for 1988-1989 (Assistant to the Dean David J. Jones pictured on page 5).

Photos by Julie Reyer

The Invisible Peacekeeper

What began as a mere thought during the Carter administration has become reality with the introduction of the B-2 Stealth Bomber to the public. The destructive purpose of the B-2 is to enter enemy airspace undetected and execute a nuclear attack upon military installations and other vital targets such as large cities. But the Air Force proposed to spend nearly 70 billion dollars on the B-2 as a peace keeping project, reasoning that no country would be foolish enough to initiate a nuclear attack if it would provoke a devastating retaliation.

There is no question that a truly "stealth" aircraft would help discourage an attack. But the U.S. cannot be sure that the B-2 will be able to slip past enemy radar. However, with the amazing innovations in the aircraft's design, the Air Force boasts that stealth planes are very difficult to detect and nearly impossible to track.

The major innovation behind the B-2 is its lowered RCS (Radar Cross Section) factor. The RCS factor is a measurement of how much an object reflects radar signals. The more large flat surfaces and corners an object has, the greater the RCS factor is. For instance, a semi truck and trailer would have an RCS factor of about 250 square meters. The original B-1 and newer B-1B have RCS factors of 10 and 1 square meters respectively. Considering the conventional shapes of these aircraft, these RCS factors are relatively good. To furthur decrease the RCS factor, it is necessary to omit as many radar "antennas" such as propellers, vertical stabilizers, and abrupt angles as possible. This explains the radical shape of the B-2. With no vertical stabilizers and minimal abrupt edges, the B-2 is reported to have an RCS factor of less than one millionth of a square meter.

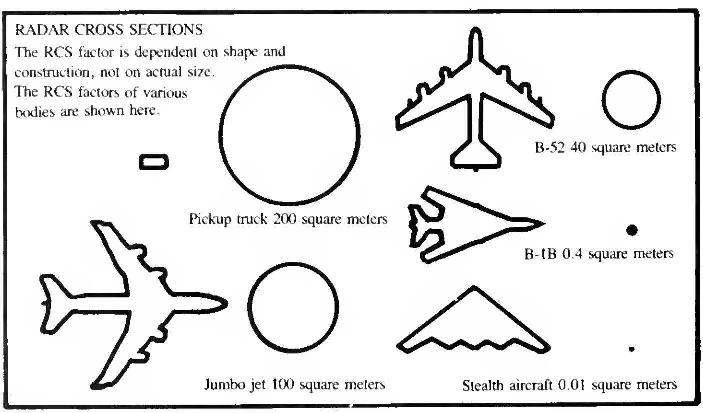
To compensate for the lack of vertical stabilizers, spoilers at the back of the aircraft are used for steering. By causing drag they give directional control. The four engines are cleverly concealed within the structure of the aircraft. This allows the turbine compressors, a source of great radar echo, to be shielded. It is believed that each intake duct is divided into a top and bottom section. The top section collects air which travels directly through the turbine compressor. The bottom section collects air that bypasses the turbine compressor and mixes with the hot exhaust, thus cooling it down. The mixture of exhaust and cool air passes through a vaned diffuser that flattens and spreads it out as it enters the atmosphere. A cooler and more dispersed exhaust makes detection by heat-sensitive satellites more difficult.

Much of the plane is composed of carbon fiber materials that are as strong as steel but reflect radar signals very poorly. The structure itself actually absorbs radar waves rather than reflecting them. Moreover, the surface is coated with a special paint that does not absorb radar signals but rather spreads them out over the surface. This coating is found to be very useful on "hot spots" such as edges and corners.

A highly sophisticated radar can detect a plane with an RCS factor of 1 square meter about 230 miles away. Engineers have learned that to reduce the detection range by 50%, the RCS must be reduced by a factor of 10. Since the B-2 RCS factor is one millionth of a square meter, the bomber can come within 4 miles of enemy radar before being detected. At a typical B-2 speed of 720 miles-per-hour, this is about 20 seconds before overcoming its target and probably long after it has released its bombs.

The B-2 Stealth Bomber is a clear illustration of the capabilities of modern science. As a result of this technology, conventional strategies of both aerial combat and nuclear assault have become obsolete. ■

By Lorenzo Smith



Drawing by Brian Switzer

Undergraduate Research At UIUC

There is no doubt that a great deal of engineering research is carried out at the University of Illinois at Urbana-Champaign. The question is, however, what opportunities do undergraduate students have to get involved in such research? Most professors feel that freshmen and sophomores usually lack the experience necessary to actively participate in such an activity; therefore, usually only juniors and seniors are invited to participate in projects. Students need the proper background knowledge (i.e. the necessary courses) to be able to make a significant contribution to a theoretical investigation. Undergraduate research provides invaluable experience that can broaden a student's perspective on the infrastructure of engineering. Also, companies look favorably upon prospective employees with resumes citing co-authorship of a published scientific report.

Professor Clausing of the Mechanical Engineering department remarked that in order for the United States to be able to sucessfully compete with such engineering superpowers as West Germany, where an engineer generally takes no fewer than six years of higher education, undergraduates must be strongly encouraged to consider graduate school. He further asserted that although undergraduate research is an excellent vehicle to that end, too few students pursue a higher degree.

Currently, there is no centralized system to assist students in finding positions for which they have the necessary training and experience. Last year, Donnell R. Hunt, Assistant Dean of Engineering and Director of Cooperative Education, initiated a pilot program to consolidate information on available positions. The response was far from overwhelming; only a few students returned information summarizing their levels of experience. It also seems a professor needing research assistants prefers students from his own class. This system has the advantage that a student is already familiar with the professor, his interests, and the way he likes things done. Although it allows for increased communication between a professor and his research assistants, it often prevents students in other curricula from taking part in research outside their specific field of concentration.

Last year, Dean Hunt sent letters to the heads of over 300 research projects to ascertain the level of interest in a service that, if implemented, would serve to centralize research-related employment. Eighty percent of the respondents stated that they would request only students of junior level or beyond, thirty-two percent would request only seniors, and three percent only graduate students. Forty percent of the respondents expected to hire non-engineers, and the same number stated the service was not necessary. Dean Hunt concluded that since the response toward the service was only lukewarm, it would not provide a major service to professors, who are routinely deluged with requests from their own students willing to take part in their research. Because the system would not be useful to the vast majority of students, Hunt felt it unecessary to implement his proposal.

Both University-operated laboratories and independent organizations conduct research on campus. Included in Dean Hunt's inquiries were groups such as the Computer Based Education Research Lab, the Coordinated Science Lab, and the National Center for Supercomputing Applications, all of which often hire university students. These laboratories are more involved with multi-faceted research. For example, a professor might be investigating the use of computers to analyze stress in bridges and may wish to hire structural and civil engineering students. When it opens, the Beckman Institute will also provide many additional opportunities for students to gain research experience.

Another important avenue for students to gain worthwhile experience is Cooperative Education. A student in this program can begin working for a major company after completing his freshman year. Once enrolled in this program, his work and study schedules are "spliced" together so he can continue to gain work experience without neglecting his college curriculum. This program has what some may perceive to be a major drawback; it requires an additional year to graduate. However, one must consider that at the end of those five years, he has already gained over a year of work experience and has been paid for it. In this program, study and work experience complement each other and thus allow a student to gain a much more thorough understanding of theory and its applications. Students are constantly reminded that they must make their resumes stand out if they wish to have good jobs when they graduate. Cooperative education will certainly catch the eye of a company official looking though a large stack of applications.

The National Science Foundation has a program giving grants to professors hiring undergraduates. This at first seems an excellent incentive for increasing undergraduate involvement in research. Many professors feel, however, that the paperwork involved is simply too stifling. Every aspect of a student's duties, as well as

(continued on next page)

a routine evaluation of his performance, must be thoroughly documented. "Most professors just aren't willing to put up with the red tape," remarked Dean Hunt. The physics department is one of the departments actively taking advantage of these grants. Dean Hunt would like to increase awareness of Engineering 110, a zero-credit course that officially recognizes participation in a research project on a student's transcript.

A different approach to gaining undergraduate research experience is to do an independent research project. Again, underclassmen usually lack the experience and knowledge to carry out such a study. In most cases, seniors take on such an endeavor.

The various college departments at the University have budgeted amounts of money to be used for research. Once the student has obtained the support of a professor, he must usually create a budgeted list of necessary materials. This requisition must then be submitted to the college for consideration. If approved, the student will be allowed to incorporate the requested items into his research project in any manner he sees fit.

The student interested in working independently must obtain the backing of a professor willing to supervise his work and lend him assistance if necessary. Often, a research topic is found in the classroom. After the completion of a class project, the student may wish to continue his research independently. If so, he can get credit by enrolling in an independent study. Such courses are offered in almost all departments.

The amount of credit given depends on the approximate number of hours the student spends on his project each week. The final decision, however, is reached by the professor along with the student. Through regular verbal contact and progress reports, the professor can track the student's work. The rest is completely up to the student.

For the past few years, Professor Richard E. Klein, who teaches Dynamic Systems in Mechanical Engineering 240, has used his class as a forum for investigating the fundamentals of bicycle function, a field that has surprisingly not been well explored. He and his students have already dismissed several long-standing theories pertaining to bicycle operation. For example, many scientists thought a bicycle stays upright because of the gyroscopic effects of wheel rotation. By placing counter-rotating wheels of identical mass on experimental bicycles, Klein and his students canceled those effects, but the bicycles were no less rideable. Other areas explored ranged from rear-wheel steering to a naive (completely vertical) front fork.

The budget for the project was $600, immense compared to a usual budget of $20 or $30. Kudrna initally worked with Link Brandon, who did much of the technical assembly. The first prototypes did not perform well because the steering mechanism was imprecise and too slow. As they continued to experiment and modify the basic design, many of the initial faults were worked out. Precision and speed were achieved through the use of a high-speed, high-torque steering motor and a chain-driven steering mechanism, as opposed to the shaft drive employed in earlier prototypes. In its present form, the bicycle functions quite well. Kudrna and his current partner, Mark Kaufman, also hope to incorporate proportional steering into the prototype.

Pictured is student Mark Kaufman with his research project.

While enrolled in Professor Klein's class last year, Paul Kudrna, currently a senior in Mechanical Engineering, conceived the idea of a radio-controlled bicycle. He was inspired by an old radio-controlled toy motorcycle. It was steered by shifting the front wheel assembly either to the left or right. If moved to the left, the center of mass of the motorcycle shifted to the right, causing the moment due to gravity to increase to the right. As a result, the motorcycle leaned and turned right. Similarly, shifting the assembly to the right caused the motorcycle to turn left. Kudrna wondered if he could adapt the principle of this technique to a larger-scale working model. He concluded that it was possible and suggested his idea to Professor Klein, who showed much interest and told Kudrna to proceed with the project.

(continued on page 11)

Photography by Dan Powers

(continued from page 10)

Although it started as a class project, the majority of work on the bicycle was done as part of an independent research project. Kudrna and Kaufman are enrolled in ME 293, a blanket course which allows them to receive credit for their work and also gives their project official recognition on their transcripts.

They meet with Professor Klein for approximately one hour each week to discuss the status of the project. In addition, Klein requests a one page typewritten progress report every one or two weeks. These reports include documentation of work accomplished, experimental results, plans for future modification, and a general overview of the project's status.

Such a project and the duties it entails--experimentation, theoretical work, field work, and compilation of technical reports--give the student invaluable experience for which companies are grateful. Whether done independently or as part of a team, undergraduate research provides a worthwhile experience that will complement a student's understanding of theoretical principles, demonstrate the problems of putting theory into practice, give the student a feeling for the level or responsibility required of him in the job market, and instill a hunger for knowledge that will remain with him for the rest of his life. ■

By A.J. Singh

When Dr. R.S. Englebrecht first took a position here in 1954, his advisor at the Massachusetts Institute of Technology told him that the U of I would be a good place to start his career but "he probably wouldn't want to stay there more than a couple of years." Thirty-four years later, Professor Englebrecht is still enthusiastically teaching and pursuing environmental engineering in a department that he has helped build into one of the most respected of its kind in the nation.

Born and raised in Indiana, Professor Englebrecht received his A.B. in microbiology at Indiana University in 1948, where he remained for one year of graduate work. He went on to M.I.T. in 1950. As a research assistant there, he was associated with one of the first federally funded research projects in sanitary engineering ever to be awarded to a U.S. university. The project included a study of the activated sludge wastewater treatment process.

After obtaining his Sc.D. in Sanitary Science from M.I.T. in 1954, Professor Englebrecht took a position at the U of I, where he has remained ever since. Over the years, he has taught many graduate and undergraduate environmental engineering courses.

At the same time, he has managed to make great research contributions to his field. His early work at the U of I dealt with microbiological problems associated with water and wastewater treatment. More recently, he has been interested in virucidal chemicals used in the disinfection of water and wastewater.

Since 1979, Professor Engelbrecht has been director of the Advanced Environmental Control Technology Research Center (AECTRC), a multi-disciplinary U of I research effort studying the technology of separation of contaminants from air and water. AECTRC is one of eight Centers of Excellence funded by the Environmental Protection Agency (EPA). He is currently involved with the National Research Council in advising the U.S. Geological Survey on the possibility of mounting a national water quality assessment program.

He was president of the 35,000 member Water Pollution Control Federation in 1978. From 1980 to 1986 he served an unprecedented three consecutive terms as president of the International Association on Water Pollution Research and Control.

Professor Englebrecht has also served on numerous committees, commissions and boards of the national government as well as professional societies, including the Ohio River Valley Water Sanitation Commission (Chairman from 1980 to 1982) and the Water Science and Technology Board of the National Research Council from 1982 to 1986. He has served as a consultant to the EPA, the World Health Organization and the National Science Foundation.

His many achievements were recognized in 1976 when he was elected to membership in the National Academy of Engineering. In 1987 he was appointed the first Ivan Racheff Professorship in Environmental Engineering.

Professor Englebrecht and his wife Mary live in Urbana. They have two sons and four grandchildren. When time permits, he enjoys reading historical biographies and playing an occasional game of above-par golf with his sons. ■

By Bradley Maurer

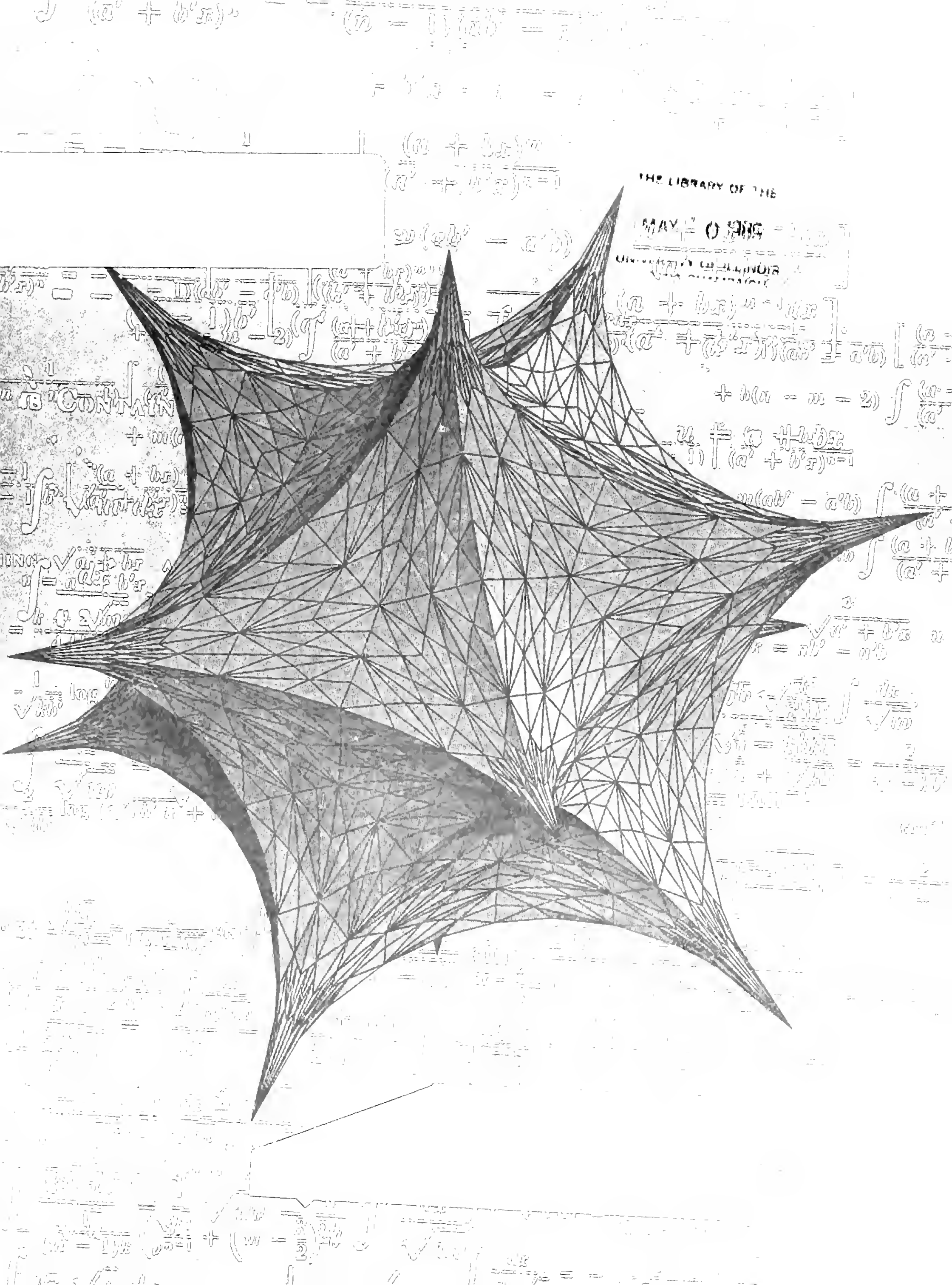
Professor Ronald Adrian has been a professor of fluid mechanics at the University of Illinois since 1972. Raised in Minnesota, Adrian received his undergraduate and masters degrees from the University of Minnesota for Mechanical Engineering. He then received a Churchill scholarship to attend university in Cambridge, England, where he studied in the Cavendish lab in the Physics department. There he had a chance to study with some of the foremost fluid dynamicists of that time. Initially intending to stay only one year at Cambridge and then return to Minnesota, he instead remained in England to receive his PhD.

In 1972 Professor Adrian came to the University of Illinois and continued his research into the structure of turbulence. His major objective is to understand the organized motions in turbulent flow fields that characterize various types of turbulent flows. These organized motions are random but are repetetive enough and occur frequently enough that one can still observe trends. In order to study these organized motions two things are needed. The first is a method of looking at three dimensional velocity fields or temperature fields, and the second is methods of statistically extracting these organized motions from the chaotic ones.

These needs led Professor Adrian to pursue research in both areas. One of his current projects is developing a new type of instrument which will be able to measure velocity vectors simultaneously at about ten thousand points in the flow. This means the structure of the flow patterns can be seen and associated with the behavior of the flow. He also believes these new experimental techniques will have applications in other areas of fluid dynamics. Another aspect of his research involves the use of results from direct numerical simulations of time dependent, three-dimensional turbulence to study organized structures. These simulations require a vast amount of super computer time, even for the simplest turbulent flows.

Professor Adrian is also active in many organizations. He is on the Board of Directors of the Laser Institute of America. He is also a member of The American Society of Mechanical Engineers, The American Physical Society, The American Optical Society and The American Institute of Aeronautics and Astronautics. ■

By Todd Veltman



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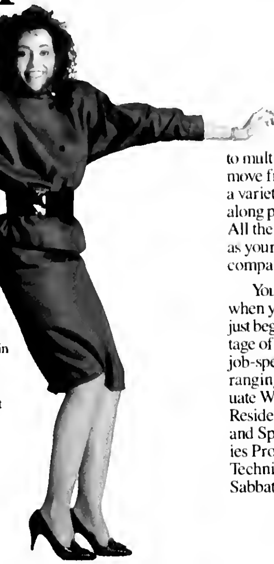

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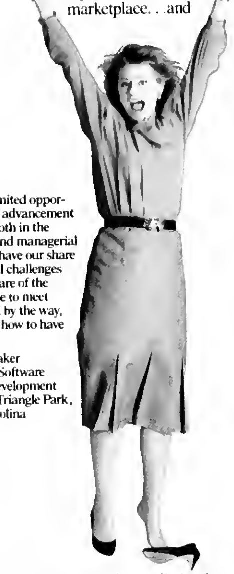

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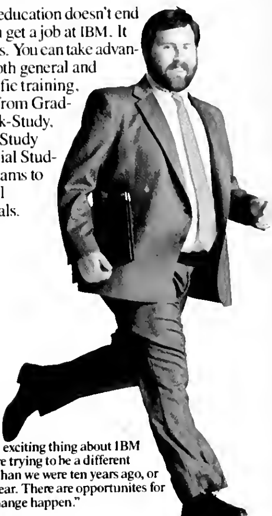
Communications &
Systems Management Designer
Research Triangle
Park, NC



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The Business of Engineering

Every engineering student I know has at one time or another pictured himself as the Chief Executive Officer of his own company or as having a seat on the board of a Fortune 500 corporation. Undoubtedly, twenty to thirty years from now, a few of the students reading this editorial will occupy exactly these postions.

You may wonder: how do I get from Champaign-Urbana to that boardroom atop Trump Tower? Of course, there is no guaranteed method of accomplishing this feat, however there are certain paths that must inevitably be followed.

Many engineers prefer the technical path, developing their skills in engineering graduate school, and accordingly "rising in the ranks" because of their technical expertise.

The other most popular path is that of people and money management, which begins with the acquisition of a Master of Business Administration degree (MBA). Many engineers choose to enhance their technical Bachelor's degrees with a MBA and pursue careers in engineering management, business, or even in entrepreneurial exploits.

Most students are knowledgeable about the implications of graduate engineering school. However, a considerable number of engineers are simply unaware of what an MBA actually entails.

At the University of Illinois, we are fortunate to have one of the most highly rated MBA programs in the nation. Generally a two year program, an Illinois MBA focuses on the development, in students, of "information, innovation, integrity, and internationalization", the four themes of its core program.

In the fall semester of the first year, students learn a variety of general business concepts. In FINANCIAL ACCOUNTING, students are introduced to accounting and reporting for a business entity to stock holders, creditors, and other external parties in order to assist in economic decision making. In MICROECONOMICS, the program teaches the principles of supply and demand with applications to business and environmental problems as well as consumer behavior and theories of production and markets. MARKETING courses introduce concepts in marketing systems and encourage the development of the students' ability to make marketing decisions. INTRODUCTORY STATISTICS courses emphasize the use of statistics in management decision making.

In the spring semester, more general business education courses are taught as a requisite to more specific subjects selected by the student in the second year.

MANAGERIAL ACCOUNTING is an introduction to the design and evaluation of management's information needs, particularly accounting information which is required for internal decision making and business planning and control. MACROECONOMICS deals with the theories of income determination, inflation, employment, governmental fiscal and monetary policies, international finance, and exchange rate determination. FINANCE provides an overview of corporate financial management, valuation theory, capital structuring and budgeting, dividend policy, financing policy, and short run financial management. QUANTITATIVE ANALYSIS OF DECISION MAKING serves as an introduction to operations research with emphasis on the construction, analysis and computer-based testing of mathematical models that simulate diverse managerial problems. Finally, PRODUCTION AND OPERATIONS MANAGEMENT examines the management of operations with topics such as production planning and control, quality assurance, inventory management, capacity planning, and capital equipment acquisition.

In the second year of the program, students are required to take BUSINESS POLICY, which is designed to explore corporate strategy formulation and implementation from the CEO's perspective. Students learn general management skills and the methodology of integrating and applying coursework to strategic management problems. Subjects covered include competitive strategies, global policies, and formulation and implementation of processes. Additionally, in the second year, students must attend a course on BUSINESS LAW. This course analyzes the legal environment of business, including the legal system and the role of courts, government taxation, regulation, antitrust law and labor laws, and legal trends as they effect business policies.

The remaining credit hours of the MBA program consist of electives in which a student can choose his or her area of specialization. These areas include: decision and information sciences, international business, finance, accounting, organizational behavior, entrepreneurship, marketing, strategy and policy, as well as healthcare management or agribusiness management.

Certainly, the MBA is an alternative to consider for engineering undergraduates who are more inclined to management responsiblity or for those who want to "switch career tracks" altogether. Indeed, many engineers from Illinois have, with their MBAs, entered into a wide variety of fields and achieved a level of success most individuals only dream of.

Whether your choice is engineering graduate school, a MBA, law school, or even medical school, each form of advanced education has its unique advantages and potential. Most important is the fact that before such a decision is made, the implications of each such option on career and goals should be duly considered. ■

Kiefer K. Mayenkar

Nothing But The Truth

Recent reports and allegations have again brought up the issue of scientific misconduct, and how it should be handled. Problems in detecting and dealing with the incidents have led to controversy over research regulation and public policy. Many universities simply lack experience in dealing with such charges and it is now necessary for them to establish firm guidelines for preventative and disciplinary action.

Within the last year, the federal government has become involved in the topic of scientific misconduct. Legislators have done what the scientific community could not: define the term, "scientific misconduct." According to the National Research Institutes Reauthorization Act of 1988, scientific misconduct is "any fabrification, falsification, plagiarism or deception" with regard to scientific work. This act also assigns the authority to conduct both random audits of papers, as well as onsite investigations of facilities, to the newly formed Office of Scientific Integrity. The responsibility to investigate charges of fraud was formerly entrusted to the National Institute of Health.

Many scientists are weary of increased government intervention, claiming that increased government regulation would be more of a burden than a benefit. The fear is that this increase in regulation would inhibit scientific creativity, as well as slow the productivity of scientific research. Another concern is that public officials often lack knowledge of the inner workings of the scientific community, and would therefore be unqualified for the task.

In some instances, it is nearly impossible to detect data that has been slightly altered. In physiological research, for example, the systems are complex and the inconsistencies in the data are difficult to detect. It is easier to spot falsified results in physical sciences since the control variables are much more rigid, and the experiments are verified through outside reproduction. Even in these fields however, according to Floyd Dunn, director of the Ultrasonic Bioengineering Laboratory here on campus, "it is conceivable that data could be doctored so that it is nearly impossible to detect."

More commonly, inaccurate data is often a result of incompetence or bias. Yet, in cases of outright fraud the main motive is the desire for recognition. According to Dunn, importance of the number of papers a researcher publishes is sometimes overemphasized. The University of Illinois, he continues, takes precautions to ensure that the quantity of publications remains secondary to the quality of publications. Before promoting a researcher, for example, scientists from outside the University evaluate the quality of his work.

Chester S. Gardner, the Associate Dean of the College of Engineering and the director of the Electro-Optics Systems Laboratory, adds that the attempt to publish in bulk produces "far too much paper in the scientific community," and that researchers should think carefully about what they publish rather than publishing all research regardless of its importance or practicality.

As a result of the importance placed in the quanitity of papers published, the practice of "honorary authorship" has been abused. "Honorary authorship" is the citing of directors and senior researchers as co-authors on papers, even though they had little or no direct involvement in the research. Gardner states that authors should be cited only if they have gathered data, provided data, built equipment, actually written the paper, or contributed significantly to the research. Gardner also feels that "honorary authorship" dishonestly credits the "honorary" author by giving him an unrealistically long bibliography.

Robert Slutsky, a junior researcher in cardio-radiology at the University of California at San Diego, had apparently been turning out works at an unbelievable rate of one paper every ten days. Slutsky had listed some 13 researchers on papers declared "fraudulent" and 25 researchers on papers declared "questionable", some of whom contributed little or nothing to the work. Perhaps the one hurt most by this was Charles Higgins, chief of cardiological radiology at UCSD, who had his name appear on three "fraudulent" and 21 "questionable" papers (Science, 31 Oct. '86: p534-5)

The current policy for handling charges of misconduct here at the University of Illinois has been in effect for about four years. When charges are made, the University first checks to see if the charges are reasonable and if further investigation is merited. This is followed by an inquiry by a committee consisting of three people: a researcher standards officer, a faculty member from within the department, and a faculty member from within the University but not that department. The current research standards officer, Eugene Giles, says that they report their findings to the Dean of the College, who decides if a formal investigation is necessary.

If a formal investigation is needed, another three person committee is formed. This committee consists of a researcher from within the department, one from within the university, and one from another university. The results of this formal investigation are reported to both the Dean of the College and the Chancellor. The Chancellor then decides what sanctions are warranted, and what disciplinary actions will be taken.

This policy is now under some revision, says Giles, because of the fact that the University of Illinois at Chicago previously had yet to adopt a specific policy. The University felt a need to have one campus-wide policy, thus slight changes were needed in order to deal with the various possible circumstances that might occur at the two campuses. Before the final draft becomes official, it is reviewed by senate and departmental committees to check for inadequacies.

continued on page 13

The Magic of Mathematica

Last semester, the Beckman Institute held a public open house. As I entered the atrium, I was dazzled by the elequent architecture, but something else there really caught my attention. There was a group of tables with several computers on them. At first I assumed that it was just another computer manufacturer trying to promote their product. On the contrary, it was a small local company known as Wolfram Research, Inc. Seeing some rather complex graphics I decided to stop and watch. This was my first formal introduction to Mathematica.

I watched for awhile and was thoroughly amazed at the simplicity of mathematical operations. What? Simple math operations? Fascinated, I continued watching as various geometric equations were solved, and functions were plotted. I was definitely addicted.

As the name implies, Mathematica is a software package that solves numerical, symbolic, and graphical computations. The program was conceptualized by Dr. Stephen Wolfram, a University of Illinois professor. Seven other developers, most of them U of I mathematics professors, were also involved in the development.

Initially Dr. Wolfram attended Oxford University. There he found the classes unchallenging and withdrew after the first year. After several published papers, he attended graduate school at Caltech. There he came to know Nobel laureate Richard Feynmann and also acquired his computer knowledge. With a group of fellow graduate students, Wolfram created the Symbolic Manipulation Program (SMP). But due to legal disputes with Caltech, Wolfram lost his rights to the program.

Wolfram and Feynmann served together as consultants to Thinking Machines Corporation, the developers of the Connection Machine (a parallel-processing supercomputer). After leaving Caltech, Wolfram joined the Institute for Advanced Study, an institute of pure research. There he studied complex systems and wrote his first book, Theory and Applications of Cellular Automata. He said that the primary goal of this book was to answer the questions that were obvious. Recently, he let this research sit, but hopes to come back to it later.

It was after the Institute for Advanced Study and after winning the MacArthur Prize Fellowship that he came to the University of Illinois. Initially, Wolfram was drawn to U of I by their offer to create the Center for Complex Systems.

The Beckman Institute, just a concept at the time, also proved to be a "relevant factor" in his decision to relocate here. Feynmann thought that the U of I was not a good location to start the Center for Complex Systems. However, ignoring Feynmann's advice, Wolfram decided to make this his new base of operations.

Now, Wolfram is a full professor in Computer Science, Math, and Physics. Until nine months ago, he was the director of the Center for Complex Systems. He gave up this position to dedicate his time to founding Wolfram Research and the completion of its product, Mathematica.

The name, Mathematica, had been suggested by Wolfram's friend, Steve Jobs, the famous designer of Apple Computer's Macintosh and the NeXT computer. Mathematica was one of several names that they had proposed, and Jobs liked it the most. He would call Wolfram once or twice a week to see if he had agreed to the name yet. Initially, Wolfram felt that the name was too long. As Wolfram said, "Mathematica just happened to be the least 'nerdy.'" Eventually, the name grew on him.

The program consists of two parts, the "kernel," the portion that does the calculations, and the "front end", which is used by the computer for user interaction. Many people believe that Wolfram wrote the entire kernel himself. Actually, eight people developed the kernel of the program. Wolfram initially wrote about one third of the kernel. Most of that one third has, however, been rewritten during further development. Wolfram said that the original code served as a good "prototype" just to see if it would work.

Two developers, Bruce Smith and Tom Sherlock, have recently joined Wolfram Research, adding to the original eight developers. Smith was already interested in Wolfram Research when he began reading the book Mathematica. Shortly after finishing the book, he met Wolfram at MacExpo, and was offered a job. Sherlock, a physics graduate student at the University of Illinois, was taking a class that Wolfram taught when he volunteered to write a graphical front end for a machine. He was later invited to work over the summer and subsequently left graduate school to work permanently at Wolfram Research.

Bruce Smith, however, is not a kernel programmer. Only being with Wolfram Research since March 1st, he is currently improving the automated tester that runs sample problems on Mathematica to detect bugs. He is ultimately interested in working on the user interface. Shelock, on the other hand is on the MS-DOS/80386 version of Mathematica.

Kernel programming is still underway. This is a formidable task since the program in its entirety consists of 150,000 lines of extended C (a computer programming language) source code. The kernel is separated from the front end to allow remote operation. The front end takes care of all the home computer's operations while the kernel, possibly running on another machine, crunches the numbers. For example, this allows a user on an Apple Macintosh to use a remote kernel on a Sun 4 workstation, a much faster computer, for quicker calculations.

While the kernels are designed to be similar for every computer the front ends are unique to every machine. Specifically, each version of the front end can utilize the special qualities that each computer posseses. Advanced Mathematica front

ends allow full screen editing, cut and paste items, and multiple windows.

The list of functions and operations that Mathematica can perform would impress a Ph.D. Numerical calculations are executed with ease. Facilities are provided for rational numbers, floating point calculations, and complex numbers. Of course, the basics are all there: summations, products, numeric integration, and root finding. Yet Mathematica makes way for more complex functions in its code: Legendre, Chebyshev, Hermite, and Laguerre polynomials, Bessel Functions, Airy functions, elliptic integrals, beta, gamma, and Riemann zeta functions to name a few.

These are just some of the numerical computations though. Mathematica begins to show its true colors when symbolic calculations are desired. Many mathematical software programs deal solely with numeric calculations. For example, if the following is entered into Mathematica:

In(1): (ab) (cd)

Mathematica will take the product of these two terms and yield:

Out(1): ac ad bc bd

Now, to find the factors of these terms:

In(2): Factor(%)

and Mathematica gives:

Out(2): (ab) (cd)

This is just an example of how Mathematica treats symbols. It allows users to calculate huge symbolic problems that would otherwise take hours or weeks, in a matter of minutes. As another example, determination of the dot product and determinant of two 3x3 symbolic matrices requires Mathematica only forty seconds, less time than is necessary to type in the original problem.

Mathematica can also accommodate many topics in calculus such as partial and total differentiation and integration. Series and limits, often a dreaded topic, is handled with ease, even when the limits are infinite. Matrix and tensor manipulations such as eigenvalues, eigenvectors, and generalized inner and outer products are also available.

Sometimes, however, the program may not know how to solve a problem. In this case one can either load one of the several packages included on the program disks, which provide extra definitions and routines, or one can create a new definition to accommodate special needs. Packages are files with pre-written definitions. When a package is loaded into memory, the definitions are automatically installed for use. Separate packages allow users to conserve valuable memory space by only loading in the necessary definitions.

One of the packages available is called Vector Analysis. This package defines other useful operations such as divergence, gradients, and cylindrical and spherical coordinates. Other packages also exist for Laplace and inverse Laplace transformations, Range-Kutta method for solving differential equations, trigonometric identities, and Ring theory. These are just a few of the over forty additional packages included with the program.

Although a certain package might invlolve a specialized subject, the operation desired might not have been defined previously. In this event, it will be necessary for the user to build a definition for the operation. New definitions can be constructed from ones already known. As an example, the Laplace transform package ordinarily is incapable of transforming (Cos(omega t))squared multiplied by Sin(omega t). Thus, in order to transform this expression, a new definition would have to be written by the user. This could then be saved for future applications. This type of flexibility is necessary to a good scientific program since the applications of tomorrow will be built upon the knowledge of today.

The graphics is one of the many enhancements in Mathematica. One can plot a function that has been calculated in order to obtain a comprehensive visual approach to the problem. Two dimensional plots show the function with various added features such as axies, labels, and frames. The user can specify various parameters such as Ticks, which adjusts the axis tick mark interval, and PlotPoints, which adjusts the number of sampling points, to create the perfect graph.

One interesting feature of Mathematica is its ability to recognize highly active regions of a graph. In the plot of Sin(x)/x the function varies infinitely near the origin, yet Mathematica adjusts its scaling to handle this complicated region.

Two dimensional plots can also be overlayed so that two or more graphs can be compared. This is very useful when analyzing scientific results. Lists of data points can also be plotted (with or without error bars). Scientific data can then be compared with known functions by overlaying them and examining deviations.

Three dimensional graphics are not only aesthetically pleasing but necessary as well. Often functions do not limit themselves to two dimensions, and a three dimensional graphical analysis simplifies visualization. 3-D graphics are simple to create.

In(3): Plot3D(Sin(x y),{x,0,3},{y,0,3}) creates a three dimensional sine wave. In 3-D graphics, the current version does not

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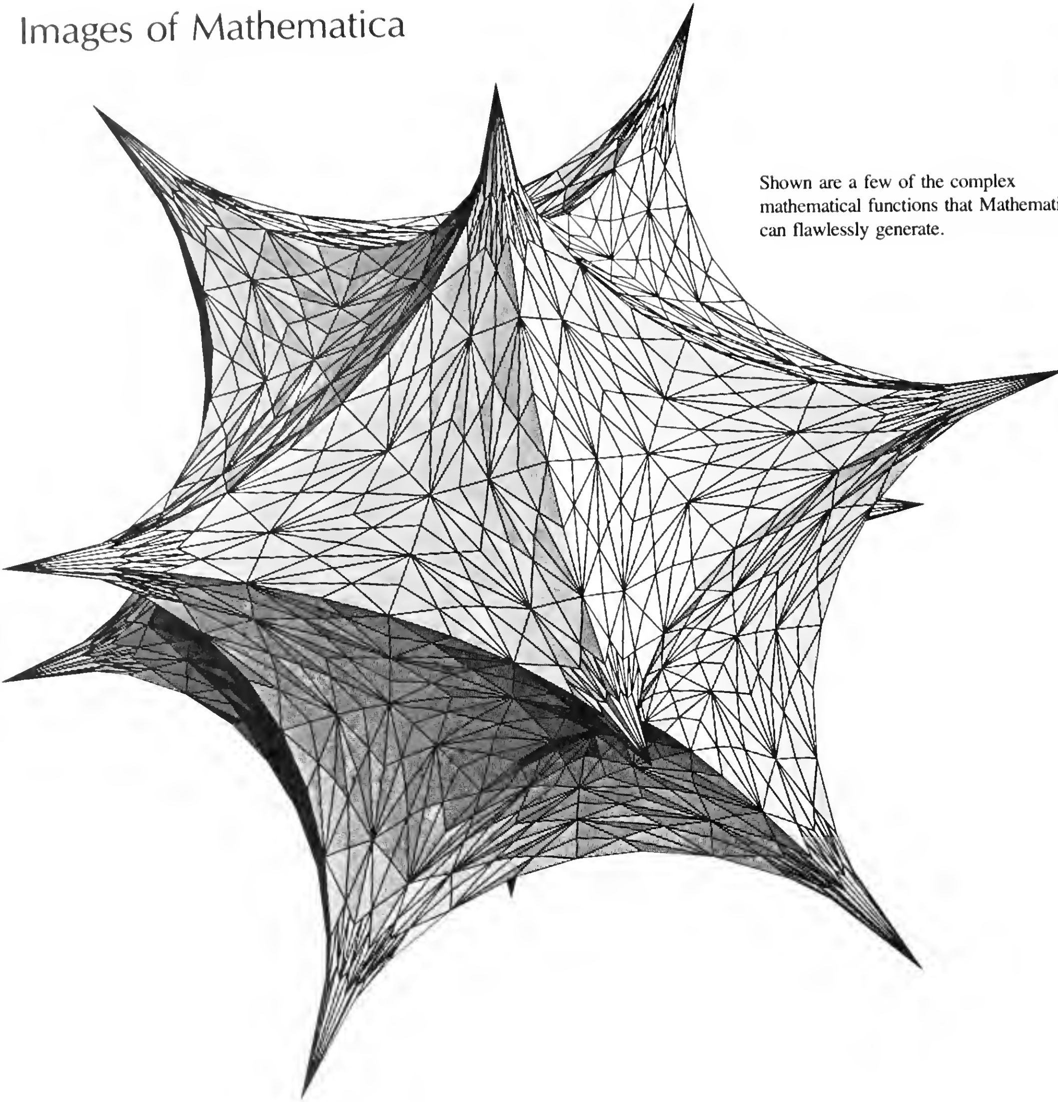
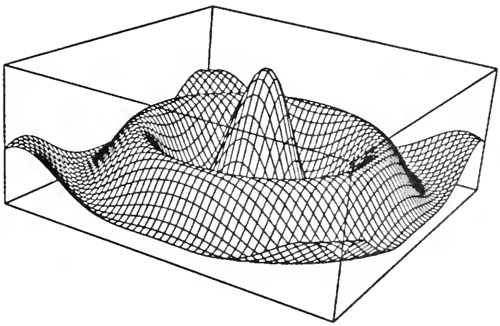
Images of Mathematica

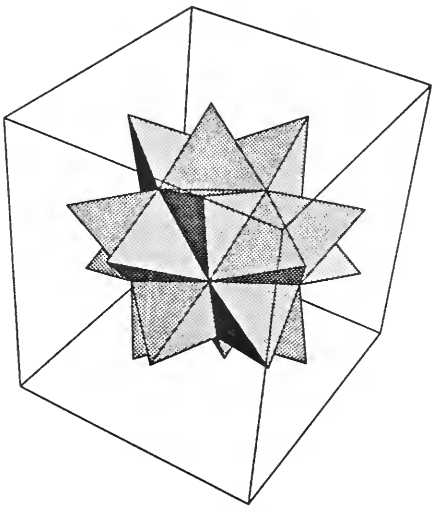
Shown are a few of the complex mathematical functions that Mathematica can flawlessly generate.



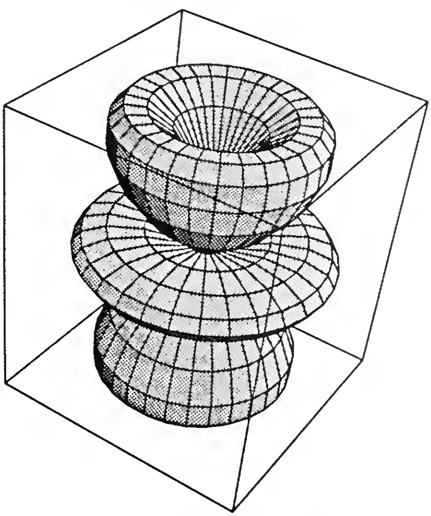
An ideal hyperbolic Icosahedron



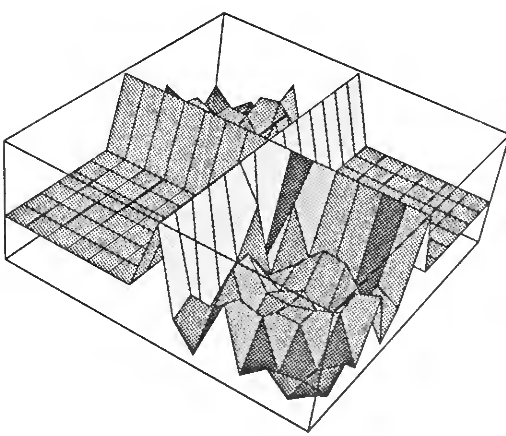
Bessel Function JO



Stellate Icosahedron



Spherical Harmonic



Airy Function

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support axis labeling. However, version 1.2, now in development, has corrected this.

Various parameters in the command can highlight the function. The parameter ViewPoint will change the observer's viewpoint so that he can see the plot at various angles. LightSources will place different colors of simulated lighting at specified locations. This will "shine" the light on the function which will retain the color depending on its orientation to the light. More complex tasks such as contour plots and density plots are also defined.

How can Mathematica be used? In many ways it is generally the best aid that a scientist or engineer can own. In the field of science and engineering, calculations required for research often involve hideous integrals and time consuming number crunching. Steve Christensen, a Senior Research Scientist at the National Center for Supercomputing Applications (NCSA), lent his testimony to Wolfram Research's latest brochure by saying, " With Mathematica, I repeated in two days a calculation that had taken me two years by other means." Upon consultation about applying Mathematica, Christensen commented, "I have been using Mathematica from its earliest test versions. My area of research is quantum gravity theory, a field where very large tensor equations abound. Equations with 1000's of terms are common and in some current theories, millions of terms can occur. Since these are symbolic rather than numerical computations, the work must be done perfectly or the result is meaningless. Hence, since a human cannot do these computations by hand, they must be done on a computer. The ideal system for my work has proven to be very high speed workstations with a lot of memory - in my case a 64 megabyte Sun-4. I had attempted for a number of years to produce code written in the C language that could do my calculations. After thousands of code were written it became clear that this would be a many year project. When Mathematica came along with its very powerful programming system and pattern matching facilities, I was able to produce Mathematica code that did far more that the massive C code that I had written. This code is now doing computations far beyond anything I can do by hand and should produce for the first time, objects needed in curved space renormalization theory - a subfield of quantum gravity - that have never been computed before."

Pictured is Mathematica operating on a NeXT computer.

Not only will Mathematica aid research, it will also aid education. Also from Wolfram Research's brochure, Jerry Uhl, a University of Illinois mathematics professor said, " Mathematica will change the way that mathematics is taught." Uhl currently uses Mathematica to supplement 100 level calculus classes. Likewise, Daniel Grayson, one of the original eight developers, is teaching Math 351, a class that details mathematical software. Grayson commented, "This course is recommended for seniors and graduate students in mathematics, engineering, and the sciences. The student will spend several hours per week in the lab outside of class learning to use the Sun workstations in Altgeld Hall, and will work independently toward the completion of various computation projects. Class sessions will be devoted to lectures or to solving in small groups." Most of the subject matter covered in Math 351 will deal with the use of Mathematica.

Richard Feynmann once sent Stephen Wolfram a letter saying that Wolfram Reseach would be a waste of time and would drive Wolfram crazy. Contrary to Feynmann's beliefs, Mathematica seems to be a success. Mathematica has brought advanced math into a new dimension. Computations will become much easier, and problems will be able to be understood without becoming lost in the algebra. Mathematica will become an integral part of education and research. The age of Mathematica has arrived. ■

Jack A. Gidding

A Closer Look At Undergraduate Research

The prospect of going to graduate school, for many students, to be introduced to the expectations of graduate school is to be involved in an undergraduate research program. One such program at the University of Illinois is the undergraduate biochemistry research program, Biochemistry 292.

Biochemistry 292 is a year-long class, open for approximately 12-15 students each year, depending on the number of professors who have laboratory positions available. The admission process for 292 begins approximately mid-way through the spring semester. Students who will have completed the Biochemistry 352, 353, and 355 sequence by the end of that semester are informed of the number of openings for the following year and are invited to apply. The application is usually only a page long; students submit a list of the classes they have completed, their grades, and an explanation of why they would like to be in Biochemistry 292, as well as some of their future plans. They also must include references, preferably from their Biochemistry 352 and 353 professor; and students admitted to the program are notified in time to advance enroll for 4-6 hours of Biochemistry 292 for the following semester. Just before the finals of the spring semester, the students and professors meet and each professor presents the type of material with which he is working. The students then submit a list of their three preferences; most students receive their first choice, but if competition for a particular area of interest is high, the professor reviews the applications and chooses the student who seems most qualified.

Students in the program usually spend the first month or so reviewing background reading and experimental techniques. By the second month, most have begun indivual research. Yet, the researchers are by no means completely on their own. While they are in the lab, other researchers of all levels, such as graduate students and professors, are available for help and guidance. So the students are continually learning new ideas and techniques as their project unfolds. They meet regularly with their supervising professors and also share information at meetings of all research lab members, during which one member presents his or her progress.

Time is essential to students in Biochemistry 292. The more time a students has to dedicate to his or her project, the better the outcome. It is not recommended that students try to be teaching assistants for first year chemistry classes if they wish to be involved in Biochemistry 292, due to the extensive time commitments required by both. It is also advantageous to complete as many core classes before senior year and to arrange other classes in a schedule that allows for large blocks of free time that can be spent in the lab. It is up to the individual student to arrange his or her class schedule in a way that permits success in Biochemistry 292, as well as their other classes.

At the end of the academic year, students are expected to compile all their work and results in a thesis paper. The quality of the paper is graded by the professor with whom the student has worked. Professors look for effort and commitment, the validity of conclusions drawn, the ability of the student to distinguish between valid and invalid results, and the scientific format of the paper presented. A student with an overall G.P.A. of 4.25 or higher who completes a senior thesis satisfactorily is eligible for Departmental Distinction. Usually about half of the papers written in a year merit a degree of Departmental Distinction. A satisfactory thesis is not necessarily contingent upon finding a solution to the initial problem confronted, but on the amount of knowledge that was added to already known facts. For example, a student may not solve a problem, but may cover a good deal of groundwork that leads to a solution in later years. There is a monetary award donated by an alumnus that goes to the student presenting the best thesis each year.

The belief that taking an undergraduate research class such as Biochemistry 292 will help a student get into graduate school is sometimes misleading. The criteria for graduate schools are essentially undergraduate grades, G.R.E. scores, and letters of recommendation. If a student fulfills these requirements and has not been in an undergraduate research program, he or she will probably be considered as qualified as a student who has equal credentials and the experience of undergraduate research. However, once the students are in graduate school, the student with research experience will probably feel comfortable in the lab more quickly. As Dr. Edward Conrad, the chief coordinator for Biochemistry 292, explained, there is a change in learning methods in the transition from undergraduate school to graduate school. In undergraduate school, booklearning and groundwork is emphasized, but this changes in graduate school. Dr. Conrad pointed out, "When you're conducting research in a lab, you're learning what nobody knows." A background in undergraduate research can ease the transition from booklearning to learning by experience.

For interested students, Biochemistry 292 can be a challenging and rewarding experience. Students are encouraged to contact the Biochemistry Student Affairs Office (401 Roger Adams Laboratory) for more information. ■

Minako Hashimoto

But Is It Really Fusion?

In late March of this year, University of Utah chemistry professor Dr. B. Stanley Pons distributed five advance copies of a scientific paper he wrote with Professor Martin Fleischmann, his colleague from the University of Southampton. Even though the paper will not be published until mid-May, copies of the paper have spread the news of the two men's controversial cold fusion experiments around the world. As news reached Wall Street, the price of palladium jumped 17%, as investors reacted to reports that it is the only catalyst known to work in the reaction.

Nuclear fusion occurs in the high-temperature interior of stars, where the nuclei of hydrogen atoms join to form helium and produce massive amounts of energy. Scientists have been trying to achieve sustained hydrogen fusion in the laboratory since the time the hydrogen bomb was developed. Until now, most fusion experiments have attempted to duplicate the high-temperature conditions found on the surface of a star. Pons and Fleischmann hoped to use electrolysis to cause two deuterium (an isotope of hydrogen) atoms to fuse, forming an atom of helium and releasing energy. If successful, the scientists would achieve nuclear fusion at or near room temperature, thus the name "cold fusion".

Pons and Fleischmann's experiment involved a small piece of palladium surrounded by a grid of platinum wires. It is then immersed in a beaker of heavy water (water made with deuterium in place of ordinary hydrogen) containing dissolved lithium-oxygen-deuterium salt as an electrolyte. The platinum and palladium are attached to the positive and negative terminals of automobile batteries.

A charging time is necessary before the reaction begins, which varies with the cross-sectional area of palladium used. Thin wires require a few days, while thicker pieces may take several weeks. After the charging time, the deuterium atoms fuse, and form helium and a large amount of energy, in the form of heat.

The experiment has been run with varying shapes and sizes of palladium, and results indicate that heat output is proportional to the volume of metal used. In one version of the experiment, a rod 10 cm long by .8 cm in diameter melted. An earlier version was blown apart when part of a 1 cm cube vaporized.

A discrepancy has led to the conclusion that unknown reactions are occuring in the experiment. As no known chemical process can explain the heat generated, nuclear processes are assumed to be at work. However, traditional fusion theories require that large quantities of neutrons be emitted from the reaction. Pons and Fleischmann, however, detected only a fraction of the theoretical quantity. Results also vary with the way energy output is calculated. In calculations involving one experiment, heat output varied from 48% to 839% of the point where energy going in equals energy coming out (the break-even point).

As mid-April approached, news of the yet unexplained discovery had feature spots on both national and local news broadcasts. Recent developments include scientists at Texas A&M University, Georgia Institute of Technology, and Moscow University claimed to duplicate Pons and Fleischmann's results. The State of Utah has also pledged $5 million for research and development of the phenomena, if it is verified as a cold fusion process. This is good news to Pons and Fleischmann, who have poured $100,000 into the project from their private funds. They did not seek grants for the project, as they believed no one would take the idea seriously.

Although the paper has been criticized for not mentioning a control experiment, and omitting some details, such as whether the beakers were sealed, and what electrical voltage level was used, Pons and Fleischmann are reportedly interested in supplying necessary information to anyone trying to test their work. Their inability to completely explain the results of the experiment has led them to hope another researcher may discover exactly what is going on.

The scientists have said that this is not any sort of sign to cut back on other forms of fusion research, as this is all very small scale energy prodution. It is expected to take decades to find an economically feasible set-up for any large-scale application. Nevertheless, speculators have come up with many possible future applications and ramifications, including cold fusion-based power plants and an overall reduction in air pollution.

It appears to be too early to start dumping coal and oil stocks, or to start buying up palladium futures. Those that do may be disappointed to hear that the metal is used very slowly in the processes being studied, and that it can also be easily recycled.

If room temperature nuclear fusion works, it may very well be, as Phillip Ross (University of California at Berkeley) commented, "The most significant discovery since fire." Unfortunately, it is at this time something to be more fully investigated, and time may show that, as Sam Hokin (Univeristy of Wisconsin) commented, "Who knows? Maybe Pons and Fleischmann have invented the world's most interesting battery." ■

Brad Shannon

The Debate Over Toxin Research

William Buck, a University of Illinois veterinarian toxicologist, claims that animal poisonings will be more frequent this season because of last year's drought. The dry spell stressed the grain stored last year (to be fed to livestock this year) by weakening its protective shell, thus making it more vulnerable to mold invasion.

This year, Buck and other scientists at the U of I College of Veterinay Medicine developed a single test for the dozens of chemicals that poison cattle, pigs and other livestock.

However, Buck's research was funded by the U.S. Army -- $3.1 million over seven years. Some U of I professors say they are suspicious that the reseach may be used for offensive biological warfare which was outlawed in a 1972 international treaty, the Biological Weapons Convention.

Buck insisted his research is beneficial to humans and animals. He explained his reseach as he juggled several phone calls at once: "You say your dog is hypersalivating? What did he do, eat the whole pen?" or "So your cat ate the geraniam. Let me check how toxic it is."

Buck has about 100,000 animal case histories stored on computer. Ten years ago he started the Animal Poison Information Center at the University of Illinois, the only center of its kind in North America. Veterinarian toxicologists answer calls on the center's animal poison hotline 24 hours a day, seven days a week. Every call is recorded on the computer and the center receives over 100 calls a day.

Buck said he suspected two mold toxins -- T2 and DAS -- were the main culprits for hurting herds of livestock each year. However, researchers could not find either T2 or DAS in the feed or in the tissue of poisoned animals.

In 1980, Buck was approached by an army veterinarian who was interested in treating humans poisoned by mold toxins. It was alleged the Soviets were spraying "Yellow Rain" on villages in Afghanistan, Cambodia, Vietnam and Laos. The U.S. Army collected samples of Yellow Rain from tree leaves and identified it as T2 and DAS. But strangely, they could not find much T2 or DAS in the bodies of the victims.

Buck and a team of at least 20 researchers found that T2 or DAS had the same poisoning effect whether the pig ate it, breathed it, had it injected, or scrubbed on its skin.

The U of I researchers also found the bodies of the pigs destroyed the mold toxins T2 and DAS within minutes. The bodies' attempts to detoxify itself broke the poison down into metabolites, the chemical byproducts. They found 28 metabolites of T2 and half a dozen for DAS. Although the pigs broke down T2 and DAS, some of the resulting metabolites were equally toxic to the pigs. It explained why the pigs were poisoned without a trace of T2 or DAS in their bodies.

"Then we asked, if animals destroy T2 and DAS, what do plants do?" Buck said. His team found metabolites of T2 and DAS in plants, after surveying 176 feed samples last year.

The College of Veterinary Medicine has the technology to identify a quantity of toxins in grain as small as ten parts per billion. According to Buck, ten parts per billion is about one fourth of an inch to the entire circumference of the Earth.

One laboratory had sacks of corn piled in a little hill next to the equipment. Urine colored extracts of grains sit in rows of beakers.

"Anything under 20 parts per billion is not likely to cause a problem," Buck said as he discussed the mold aflatoxin. "But grain with 20 contaminated parts per billion can't even be shipped interstate, according to the Food and Drug Administration. Remember, we're talking about very, very small quantities." Illinois and Iowa have aready begun statewide testing of mold toxins in harvested crops.

Buck said this research can be used to defend the United States from biological attacks. "If terrorists wanted to hit this country, they could spread spores of molds on our crops or in feed bins. We wouldn't know it until we did a test."

Nachama Wilder, the executive director of the Committee for Responsible Genetics in Boston, said "it is difficult to distinguish between offensive and defensive warfare research. In order to defend yourself, you need to know what you are up against and then create a vaccine. The best defense is to strengthen the Biological Weapons Convention of 1972."

Democratic Representative Terry Bruce of Illinois said he was opposed to biological warfare. "But (Buck's research) sounds like it is not related to uses in chemical or biological offensive warfare. I see nothing wrong wth developing a system that could help save lives if somebody else used chemical or biological weapons," said Bruce in a prepared written statement. Bruce also said we cannot avoid scientific advances just because someone might misuse them in the future, according to Michael Bushman, Bruce's press secretary.

Another public official who supported Buck's reseach was Charles Smith, defense advisor to Democratic Senator Alan Dixon of Illinois. He said the U.S. Army is required to look at biological offensive weapons used by our enemies.

"These are horrible weapons," Smith said. "But how do we protect our troops from it? How do we develop defenses against chemical weapons used by Iran, Iraq and the Soviet Union.?"

Some U of I life scientists applaud the veterinarians for doing the research, but resent the fact that the money is channeled throught the Department of Defense instead of the National Institute

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of Health or the National Science Foundation.

"If the military funds too many things, we can't wade through all of them," said Stanley Maloy, a U of I microbiologist. "It would make it easier for them to hide research used for offensive purposes from the public. All health research with no impact on biowarfare should be funded by the NSF or NIH."

"I don't blame them for accepting the money from the Army," said Abigail Salyers, a U of I biologist. "Research money is tight. My concern is that the system is wasteful. It's bureaucratic. Proposals must go through a duplicate process, once for the NSF and one for the Department of Defense."

Democratic Representative Wayne Owens of Utah will present a bill to Congress that will put all biological warfare research not purely military under the responsibility of the National Institute of Health. Under the bill, biological research with any non-military applications will be funded by NIH. There is one exception and that is the testing of equipment.

"Under the bill, the U of I project on toxic molds would be funded by the National Institute of Health because the research is not specifically military," said Paul Warenski, press secretary to Owens.

Buck said the millions of dollars from the Department of Defense provided him with computers, biological equipment and more researchers, which pushed his team into finding a diagnosis for the mold toxins.

Ten years ago, Buck received only $150,000 from the U.S. Department of Agriculture "and then Congress cut the money," Buck said. "We never would have developed the test without the $3.1 million. No way." ■

Iris Chang

Exceptional Advisors Honored

The most often heard complaint at large institutions such as the University of Illinois is that the education students receive is very impersonal. The complaint is not a suprising one considering that a professor must lecture to a room of 100 students or more. Students tend to be treated as just another face in the crowd.

The function of advisors is generally to alleviate some of the impersonality in large school systems. However, a problem similar to the large lecture hall effect still arises. A professor must also tend to his research and graduate students in addition to advising undergraduates. The problem then arises of the professor not having time for the problems of the undergraduate. However, once in a while, there is the advisor who puts forth an extra effort to get to know his undergraduate advisees. He will receive no extra grant money or accommodation for his efforts; rather, he invests the time in his students just because he cares.

A student may receive an award for scholarship, activities or athletics, but rarely are students given the opportunity to reward a particular professor for his outstanding efforts. On the night of March 7, 1989, there was such an opportunity as the Dean's Student Advisory Committee and Arthur Anderson Consulting Company presented the first annual Advisors Award Banquet. Twenty-six advisors from engineering curricula, ranging from Agricultural to Theoretical and Applied Mechanics, were recognized for their dedication to the undergraduate students of U of I. This dedication involved not only giving helpful hints as to the best classes to take, or the best companies or graduate schools to apply to, but also taking the time to listen and help out with students' problems outside of the classroom.

The candidates for this year's Advisors List were first nominated by students and the final list was decided upon by a student selection committee. The banquet was opened by Morton Weir, the Chancellor of the University of Illinois. Then the guest speaker, Daniel Metz, presented a few words of wisdom to help engineering students through life, as well as through school. His speech was a fine example of professors' concern for students. Professor Metz demonstrated that he not only cared about how students performed in class, but also about how students performed once they left the university.

Large universities do not necessarily have to be impersonal or uncaring. The Advisors List of 1989 proves that there are professors who are concerned about undergraduates. Hopefully, this award will encourage other professors to become more concerned in their role as undergraduate advisors. ■

Grace Wilson Award

Have you ever heard of Michelle Ohms? Well, if you haven't, somebody has namely the board that selected her as this year's recipient of the Grace Wilson Award.

The award is presented in honor of Grace Wilson, the first female engineering instructor at the University of Illinois. The Women's Auxillary of the Illinois Society of Professional Engineers dedicated this award to Grace Wilson for her contributions to women in the field of engineering.

To receive the Grace Wilson Award, a candidate must be one of the top ten women engineers in her curriculum. She should be academically excellent, an outstanding contributor to the community and/or the university, as well as a contributor towards her own education, either by jobs held, internships, etc. On February 25 at the Champaign Country Club, Michelle's father and sister watched as she was presented the Grace Wilson Award by Dean Wakeland and Professor Jerry Dobrovolny.

So, what was it that Michelle Ohms did to deserve this award? Take your pick: she was a member of Tau Beta Pi, which is the National Engineering Honor Society, a member of the American Society of Mechanical Engineers, the Society of Women Engineers, a member of Engineering Council, the Engineering Speakers Bureau, Homecoming Queen for 1988, a U of I Concert Band member, and a Knight of Saint Patrick, which is an honor given by the College of Engineering for outstanding involvement in extracurricular activities. If this were not enough to keep her occupied, Ms. Ohms studied abroad at the East China Institute of Technology in the summer of 1987.

So even if one had neither met nor heard of Michelle Ohms, her work and achievements have shown up all over the engineering campus, which is why she was bestowed the Grace Wilson Award. ■

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The policy is in its final stage of revision, and is expected to be implemented shortly.

Admittedly, it will be impossible to completely free science of fraud. Nevertheless, as science progresses into the next century, issues centering on its regulation must be resolved. Many universities other than the University of Illinois have begun formulating formal policies, and other portions of the scientific community will need to do the same. Otherwise, increased government intervention and its immediate results will be inevitable. ■

Dave Kenyon and Steven Phelps

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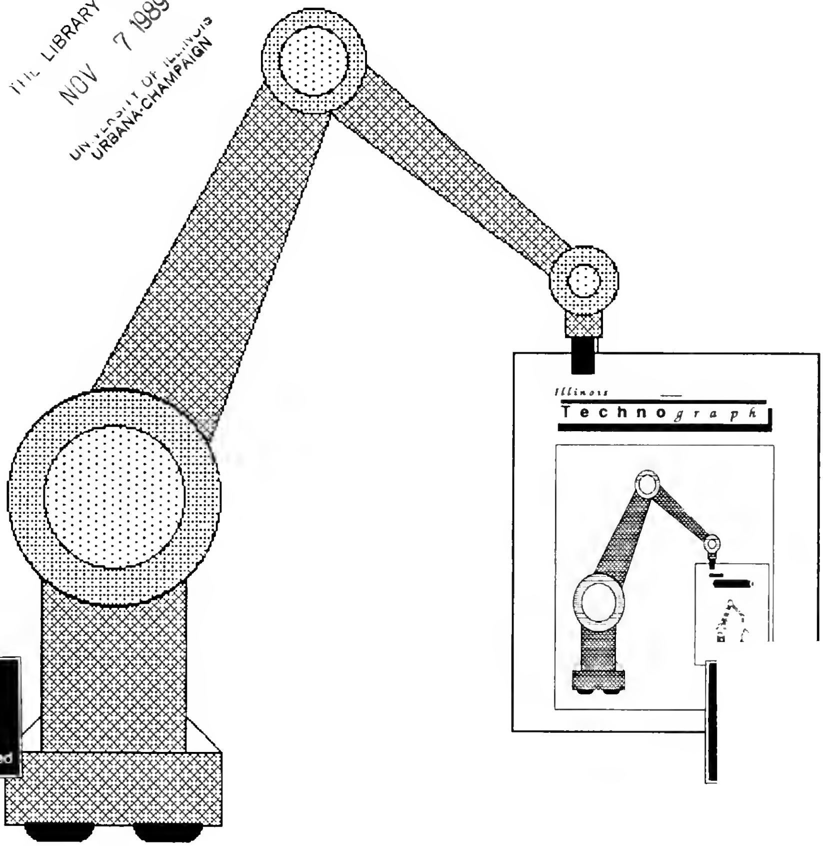
Volume 105, Issue 1

Technograph



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Green Street
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The Engineering Magazine at the University of Illinois

Editorial

". . . why then should we give two leaking barrels of toxic waste about what happens to the environment?"

For those of you who missed the REM concert at the University of Illinois due to test, homework, lack of tickets or some other reason, hopefully you did not miss the objective in promoting their "Green" tour.

"Green" does not refer to the color you feel after taking a EE exam nor does it refer to Kermit the Frog; rather it refers to the color of the trees, flowers and other vegetation that is slowly being decimated by man.

Rain forests are responsible for supplying about two-thirds of the oxygen for this planet and are also contributing factors in global weather patterns. The algae in the oceans supply the other third. So, even if all of the rain forests were burnt to the ground for Columbian farmland, we really need not concern ourselves. Sure, breathing may become a little difficult, especially with only one-third of our normal oxygen present, and large amounts of pollutants will enter our systems causing the incidence of lung cancer to increase, but the human race could probably still survive (albeit not in complete comfort). We will not all drop to the ground blue and twitching just because there aren't any trees left, but our quality of life will be greatly affected. The same is true of the hole in the ozone layer. There most certainly will be more mutations, eyesight will fail earlier in life and the wildlife will be annihilated, but the human race is much like the cockroaches; come acid rain or nuclear disaster, we will probably pull through.

Since it is not the human gene pool which is in jeopardy from our own actions, why then should we give two leaking barrels of toxic waste about what happens to the environment. After all, by the time earth begins to fall apart, most of us will be dead.

The answer that question is to preserve that essential quality that makes man human. Man is the only creature with the capacity to destroy or preserve the earth. Ordinary animals, such as elephants, may lay waste to many trees during a single feeding, but they cannot restore that which they have destroyed. Man is also the only creature that can appreciate the beauty around him and ensure its continuation.

If steps are not taken to stop the destruction of the trees and plants and the pollution of the atmosphere and earth, the future of this planet is a bleak one. The only wildlife that will remain will be giant sewer rats and cockroaches; the air will be toxic to all living beings; and the ground upon which we walk will be a sludge of toxic waste and garbage.

So go ahead, plant a tree, but not because you want to contribute that millionth of a percent to the earth's flora or atmosphere. Plant that tree because you respect the earth and everything with which it has provided you, but also recycle glass, plastic containers, aluminum cans and paper and do everything you can to become more environmentally conscious.

Plant a tree. ■

Chi-Ting Huang

Chi-Ting Huang
Editor

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Techno*graph*

Departments

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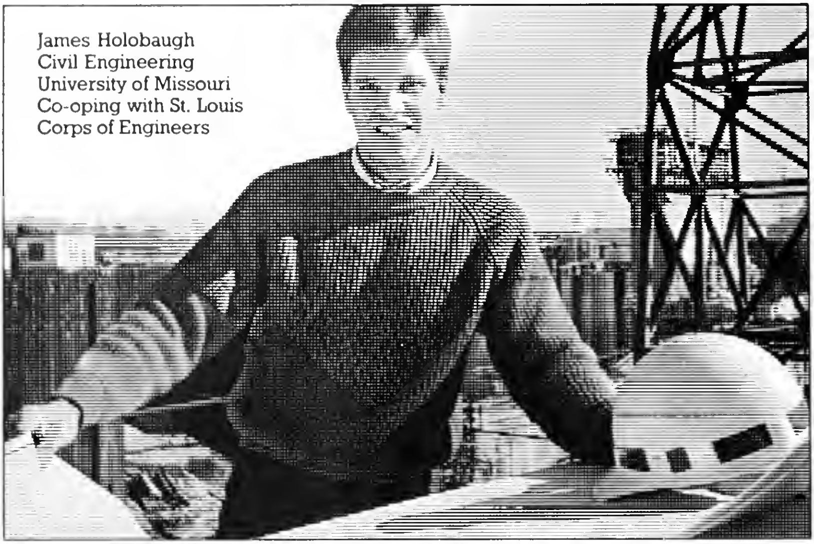
Campus Coverage

RESERVE OFFICERS' TRAINING CORPS



"THE DASE CO-OP PROGRAM IS LIKE A COURSE IN REAL LIFE."

"The big thing it offers is experience, and that's what companies look for. There are things I've learned on the job that I couldn't learn in school."

The Department of Army Scientific and Engineering (DASE) Co-op Program provides ROTC students the opportunity to work in a Department of the Army facility while still in college. Each is paid while getting practical work experience in a high-tech facility. Selected students also receive up to $5,000 tuition assistance per year and the opportunity for continued employment after graduation.

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Computer Illiteracy on Decline

Seldom has technology required the layman to not only learn a new language, but to also learn a completely new style of thinking. We have arrived at perhaps the first major sophistication of that type since the invention of the printed book. The computer, which once heralded a new age of information, has issued forth an age of confusion. The world now seems to be in a state where those who are "literate" with computers can truly claim a certain superiority over those who are not. The problem of computer illiteracy becomes more pronounced as computers continue to proliferate work, home, and social life at a breakneck pace.

Much of the problem lies with those people who are forced into a confrontation with the computer on the job. Workers who have had no previous experience with computers find themselves ill-prepared when they are under pressure to learn how to use a computer on the job. Some suffer what might be termed as keyboard paralysis. Even if they learn basic computer skills, some people will freeze before they touch a computer keyboard because of the anxiety they experience. They wonder if touching the wrong key could break the computer or erase important information or programs. Those who get past keyboard paralysis may get so frustrated after a few mistakes that they think they cannot master the computer.

Perhaps one of the biggest problems of job-related computer anxiety occurs in the teaching profession. School districts often buy computer systems or networks but do not spend time training teachers how to use the systems or how to coordinate the computers with their classes. The teachers, told that they must integrate the computers into the classroom, attempt to do so with their limited knowledge, but may be intimidated if their students pick up computer skills more quickly than they do. Because the minds of children are more open and have fewer preconceived notions, they often do pick up skills more rapidly than a teacher who may feel his workspace has been crowded with an intimidating competitor.

A more subtle effect of computer illiteracy is its effect on a

person's power to believe or disbelieve. Computers possess two aspects which increase believability in their computations and products immensely. Computers are close cousins to machines, and they are masters of the printed word.

People trust machines. There is little else to say. How often does one experience a faulty toaster or a television on the blitz? Machines have become so reliable in the 20th century that society has placed a great deal of trust in them. People naturally try to associate the relatively new concept of computers with a concept they are already familiar with, and the concept of a machine is by and far the one with the most similarities. However reliable a computer may be, it is only as reliable as its programming and its data input, both of which involve the human factor to some extent.

People also trust the printed word. This may be because the educational system relies so heavily on printed texts. People may place their trust in a laser quality document such as a resume or a term paper without relying as much on its content as its appearance. Additionally, trusting in a computer-printed bank statement might seem perfectly reasonable while trusting a hand-written bank statement would seem a little more absurd. Considering that similar errors could be made in miscopying numbers, and that a number could be miskeyed, perhaps the printed output ought to deserve a second look. To continue living effectively in a computerized society, people should learn to be more skeptical of printed material since it has become so easy to produce.

The College of Engineering at the University of Illinois has joined the effort to solve the problem of

computer illiteracy by doing what it does best — educate. The Strategic Planning Committee for Computing and Networking (SPCCN) plans to move forward with its renovative efforts based upon the recommendations of an instructional computing workshop it hosted last year. Currently, the SPCCN and other committees are working toward two definitive goals for the College of Engineering.

The SPCCN, chaired by Dean Chalmers Sechrist, proposes the installation of high-performance workstations such as industry commonly uses. According to Sechrist, many graduates of the University enter industry before familiarizing themselves with standard high-performance workstations. Since most industrial employers expect job applicants to be familiar with these workstations, Sechrist wants them to receive hands-on training at the University.

Another goal recommended by the instructional computing workshop is better education of freshmen about computers. Although this plan is not currently under the wing of the SPCCN, there are proposals to establish an entry-level course to teach freshmen about computer basics, a revised version of CS101, and possible follow-up classes which might teach computer usage specific to each student's major.

The computer literacy problem is definitely becoming less of a concern. More people learn every day that they have nothing to fear from computers, however, computer literacy must continue to improve on a personal, university-wide, and nation-wide scale, for computers will continue to spread into more aspects of our culture even if some people are left behind. ■

--John Fultz

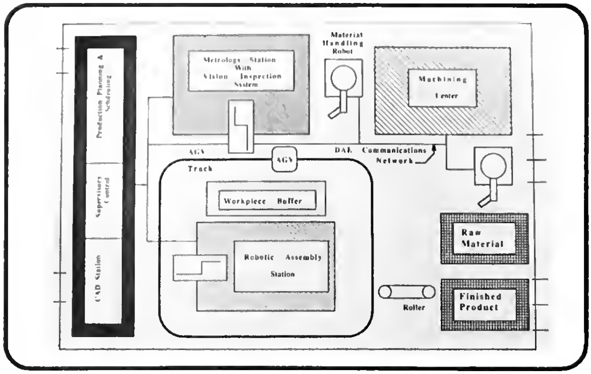
Flexible Production Comes to U of I

Every engineer wants to make that once in a lifetime design that will earn him fame and fortune, but that product must be manufactured in a quality and cost efficient manner to satisfy both the producer and the consumer. Henry Ford revolutionized manufacturing with the concept of an assembly line; and in the 1980's, the revolution continues with a trend towards completely computerized manufacturing. One concept that is becoming popular among large manufacturers is the concept of the Flexible Manufacturing System (FMS). Recognizing the importance of the FMS, the University of Illinois College of Engineering has begun offering a manufacturing option which affords students the opportunity to work in an FMS lab.

A conventional manufacturing system is considered to be a system which integrates different processes (machining, welding, etc.) and requires a properly defined input to create the expected output. Setting up a conventional manufacturing system requires process planning, sequencing and scheduling, and facilities layout for the production of a single batch of products. Also, many of the processes are performed manually while some are performed with the aid of computers (e.g. Computer-Aided Process Planning, Computer Numerically Controlled machine tools (CNC), and Computer-Aided Design (CAD)).

One of the goals of FMS is to use a computer (or Computer Integrated Manufacturing (CIM)) to fully integrate the electronic output and create the expected product. As expected, the FMS is very close to being fully automated. Another goal of an FMS is to have the ability to adapt to any change in input parameters (e.g. product dimensions, configurations, or overall change in design) without creating many problems.

One good way to get a good grasp of what FMS is would be to examine the proposed Flexible Manufacturing Cell for the College of Engineering (fig. 1).



At first the product is designed and stored on a CAD system, then the information concerning the design is read by another computer system and is used to ensure the proper production and process plan along with the proper scheduling of events. Included in the process plan is the CNC code generated for each part to be machined.

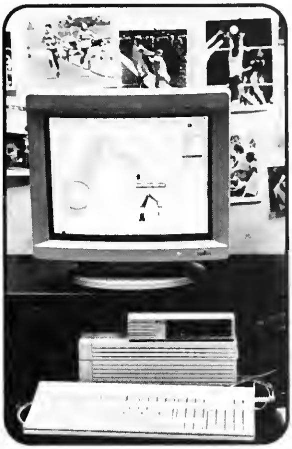
After all of this is completed, production is ready to begin. At this point, the supervisory control station downloads the CNC part programs to the machining center via the communications network. Once the downloading is complete, production finally begins. Now, the supervisory control initiates the first material handling robot to begin production. The robot then transfers raw material to the machining center. Once the material has been machined, another material handling robot transfers the finished part to the metrology station where the part is inspected to see if it meets the required specifications. While all of this is going on, the supervisory control is monitoring everything. Therefore, if the metrology station detects any problems with the machined part, it discards the part and notes that a replacement is needed. If there is a consistent flow of improperly machined parts, it senses that there is something wrong with the machining process and either makes the proper adjustments during the process (via the communications network) or shuts the system down depending on the complexity of the problem.

After the part has been inspected, the part is transferred to an automated guided vehicle (AGV) which brings the part to the robotic assembly station. Here a robot takes the part and places it in a workpiece buffer until there are enough parts present for the robot to begin assembly. After assembly is complete, the AGV transfers the finished product to a product bin.

The manufacturing cell will produce robots such as the one in fig. 2 which was designed on a CAD system. Small alterations in the design of the individual components of the model robot allow the robot to be constructed in different ways demonstrating the flexibility of the manufacturing cell (fig. 3).

The importance of this system to the College of Engineering is twofold. Firstly, the construction of this system draws from almost every discipline in engineering. For example, the communications networks for the computers as well as the CAD system draws on computer science and computer engineering. The control of the machine tools and

robots draw from electrical engineering; the machine tool and robot structure draw from mechanical engineering; and the process planing and scheduling draw from industrial engineering. By integrating almost all of the disciplines of engineering into a single laboratory, engineering students who take classes using this lab can see how they relate to engineers of other disciplines.

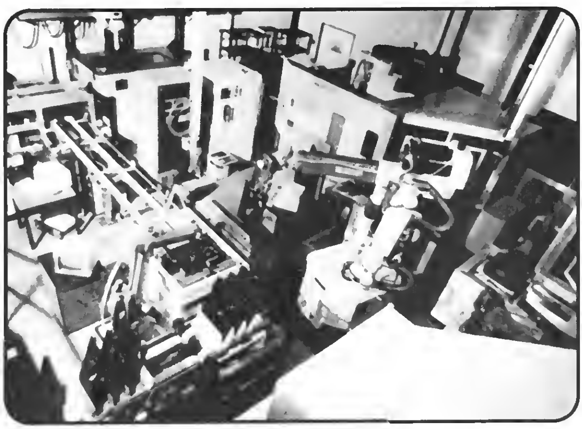


Secondly, the manufacture of designed products is the concern of engineers from all disciplines. By understanding basic manufacturing principles, the design engineer will be able to better communicate with the manufacturing engineer and vice versa. Enhanced communication will result in products of increased quality at a lower cost.

Because of the need for engineering graduates with a basic knowledge of manufacturing processes, systems, and issues, the College of Engineering is currently designing a "manufacturing option" which will be available to all engineering students as a complement to the standard bachelors degree. The expression of this need for engineering graduates with the basic knowledge of manufacturing came from General Motors Foundation which has provided some support for setting up the FMS laboratory for the manufacturing option.

The program's director, Dr. Shiv G. Kapoor, has designed the program to allow the student a perspective of manufacturing from the point of view of his respective discipline of engineering. The program consists of three levels. Level one is a single course titled "Introduction to Manufacturing Systems" which all students in the program are required to take. Level two will be a set of four 300 level courses under the new manufacturing engineering (MfgE) classification from which the student will have to choose. Level three will require the student to choose from three courses in a group of technical electives. It will be required, however, that the level three classes be related to the level two in order to generate a more coherent study. The projected completion date of this program and the FMS cell that it complements is August 1990. For further information concerning the FMS cell or the manufacturing option, contact Dr. Shiv G. Kapoor at the Department of Mechanical and Industrial Engineering, phone 333-3432. ■

--Allen Brandt



Studying Abroad in Germany

My last year (academic year 88/89) was spent in Munich, Germany, as a participant in the exchange program between the UIUC College of Engineering and the Technical University of Munich. Studying abroad offers many opportunities to expand a students mind. I, myself, gained a variety of insights from my year abroad.

A year abroad affords a variety of culturally different experiences. These range from local cultural aspects (i.e. tomato fights in some Spanish city), to regional traits (such as language, food and festivities), to general views of a different society. Some of the regional characteristics of Bavaria were the mountains and lakes, the smattering of dialects, yodeling, and a very strong pride in Bavarian beer.

The main attraction offered by Europe as a whole, can be summed up with the word "diversity" - a rich diversity in its languages, political systems, and cultures, and the wide array of geographical areas existing in close proximity. This diversity results in a very full and interesting history, traces of which are scattered all over the continent.

Before arriving in Germany, my goals were all very structured. My main goal was to better my math skills and come back as Einstein II. Some secondary goals were: to turn into the bike touring nut of the north, to get into Olympic caliber swimming condition, to rip through France and Germany and to know the language and culture like the back of my hand. None of these goals were actualized. I cracked open two of the thirty-seven books I shipped over; my bike got very little use due to excessive rain and bike-damaging streets; I hurt my shoulder and started to get fat; and I came to dislike traveling unless I had a specific goal and itinerary.

A study abroad experience is an open possibility - a giant unknown with a good chance of being one of the best growing experiences in life. Having been part of a relatively unstructured program, it has been my observation that one leaves for a host country with certain preconceived notions. Upon arriving, unpleasant surprises and disappointments go hand in hand with the intrigue of being in a foreign country. Once the system is understood, you can start to set realistic goals regarding courses and work. Of course, the outcome of all this work is that just as you have finally gotten to know the system, and have become integrated enough to achieve some goals, you have to pack up, leave, and readjust to U of I.

So, what am I saying? I am saying that my year abroad was an invaluable experience which taught me about both myself and the world. The opportunity is open to everyone, and everyone should take advantage of it. If you have not studied abroad, you have no idea how much you can get out of the experience and never will unless you try it. If you have certain things you would definitely like to get accomplished, a more structured program is for you; but be warned, with increasing structure, you proportionately compromise the variability and flexibility that makes this such a good learning experience.

If I had to make the decision again knowing what I know now, I would certainly go but would postpone my trip until after graduation simply because going away in the middle of Sophomore and Junior year is quite an inconvenience. It most certainly would be far easier to cruise through undergraduate years uninterrupted, then switch gears after the natural break of receiving a bachelors degree. But integrating back into the old life has its merits, simply because you get back on track, changed only in that you are a broader, more developed person. I can imagine losing quite a few good people to other countries, simply due to them not wanting to start over again in America. But going abroad during your undergraduate years ensures you an easier return and more importantly gives you a home base (your University) and a source

of funding (again, your University). Once you do return, you will see that the readjustment goes fairly smoothly and that you have magically become more attuned to what you want to get out of life and how to go about getting it. You suddenly begin to appreciate America's rich cultural and geographic diversity and to view nearly everything based more on its global impact as opposed to how your own little corner of the world has been affected.

You should think very carefully about at which point in your life you would most willingly get involved in a study abroad program. What you lose in continuity, you make up 1000-fold, in having limitless new opportunities open up because you can now view things on a more global scale and assess them more fully. To sum up, studying abroad is certainly a break in your life's continuity, and I think that transitions are almost always accompanied by many disappointments, but also with a more worthwhile gain. ■

Perspectives in Space Technology

Technological advances in fiber optic communications, robotics, supercomputers, microelectronics and new materials are beneficial in themselves and also in their interdisciplinary applications. One application to which they all pertain is space technology. Efforts in space exploration and utilization have been progressing remarkably in the post-World War II era, and fascinating breakthroughs have contributed to the shape of modern living.

The uses of space are often thought of in military and defensive terms like long range reconnaissance and nuclear explosion detection, or in terms of communication satellites for business. However, there are many other branches of space research and application that are less publicized. For example, solar power satellites for terrestrial energy production could supply large amounts electrical power without the chemical or thermal pollution associated with most conventional energy sources. Also, space manufacturing and materials processing under variable gravity will make the building of large scientific instruments like radios and optical telescopes much easier. Further, satellites and other exploration machinery made in space and launched from, say, the moon, would require only one twentieth of the energy required for an earth launching.

All this production in space would be even more efficient if the needed materials were actually already in space. Their existence is just one question to be answered as space technology tries to expand knowledge of the universe. Remote sensing of materials by space satellites is also an important application. For instance, the Apollo missions were instrumental in obtaining the chemical composition of lunar soil (by weight, 40% oxygen, 30% metallic elements such as iron, aluminum, and titanium, and much of the remainder is silicon). Remote sensing is also useful in the exploration of the earth's oceans and other hard to reach areas. This is especially important for locating deposits of materials that are becoming scarce.

As with any mode of exploration, lessons learned from earlier failures must be applied to future efforts. The Challenger disaster brought out the need for improved safety in the future design modifications of space vehicles. The success

of the space shuttle Discovery after the disaster of Challenger is a positive sign for future missions.

Future space activities, to a large extent, depend not only on political, social and economic factors but also on public support and awareness. The future still holds the much awaited days of a permanent space station with opportunities to perform experiments that may help produce new materials and gain new knowledge. The possibility of creating habitats on other planetary bodies such as the Moon, Jupiter and Mars has posed difficult yet intriguing challenges to the creativity of investigators. Mining the vast amounts of resources of other planets and the harnessing of the sun's energy are also subjects of investigation.

Space exploration pushes us to the limits of our technological abilities. Many ideas have been realized, and the twenty-first century will hopefully provide more pathways towards actualizing our space dreams. ■

--Karthik Nagarathnam

Tech Profiles

Professor Ilesanmi Adesida, commonly known as "Ade," is a faculty member of the electrical engineering department at the University of Illinois. He first came to the United States from Nigeria in 1971. He attended the University of California at Berkeley and earned his B.S., M.S. and Ph.D. in electrical engineering. Adesida suggests that eager undergraduates stay in school and earn their M.S. before beginning their career. "You really start to learn in graduate school. In your classes you don't use the results of your studies; you produce the results," he pointed out. Another suggestion was that students find a part-time job in their respective fields while still in college. "If they can find a part-time job, the experience will be a good commodity in the future." In 1979, he went to Cornell and there he held such positions as a post-doctoral fellow, a research assistant and a visiting assistant professor. Adesida stayed there until his wife completed her residency as a physician.

In 1984, he returned to Nigeria to help with the education of students there. In 1985, he became the head of the electrical engineering department at a new school in Bauchi, Nigeria called Abubakar Tafawa Balewa University. There he helped create their electrical engineering curriculum and set up the undergraduate laboratories. In the beginning, their labs were modest. One of their first labs consisted of injecting signals into a torn apart radio; but now the school has grown and is able to obtain much more sophisticated lab equipment.

In early February of 1987, he returned to the United States to teach and research at the University of Illinois. So far, he has taught EE340 and EE344 which are classes that deal with semi-conductor theory and production. His current research project concerns physical electronics and microfabrication technology for high speed devices to be used in future optical communication and computer systems. He believes that the transistor will eventually work on the atomic level with single electrons, and quantum mechanics will have to be used instead of classical physics to examine these devices. His laboratory is located in the basement of Everitt Lab at a place commonly known as Fab 2, but he will be moving to the Microelectronics Lab behind Kenney Gym.

Adesida predicts a bright future for the University of Illinois with the new Digital Lab, the Microelectronics Lab and the Beckman Institute. He believes that the opportunity for many professors to work together through the Beckman Institute will be extremely rewarding in terms of research possibilities. He views the University of Illinois as being on an equal level, education-wise, with Berkeley and also that "the school [the University of Illinois] will maintain its standard of quality."

When asked to compare the schools in the United States with the school in Nigeria, he said that there was only one major difference. In Nigeria, professors are highly revered and respected and almost put on a pedestal by the students. Adesida believes that this high regard is a good idea, but too high of a regard makes it difficult for students to approach a professor with questions. In the United States, there is respect for the professors, but there is also a friendly bond between the student and the teacher which makes asking questions and learning in general much easier.

Professor Adesida is a person who really wants students to learn and wishes them the best of luck in their future careers. This father of five children and player of tennis and ping-pong has one down-to-earth message to students, "Hard work pays in the end." Hopefully the students can use this bit of wisdom to endure that next class assignment that seems to have no solution. ■

--Ken Skodacek

Who says engineering students can't write?

If you would like to write for the Technograph, contact Chi-Ting Huang at 328-6808 or Minako Hashimoto at 332-4383. Earn approximately $10/article. Jobs also being taken for photography and layout.

TechTeasers

1. What monosyllabic English word has one vowel and eight consonants?

2. A man owns 23 rare exotic guppies. In his will, he designates half of his property to his eldest son, a third to his middle son, and an eighth to his youngest son. Since these rare exotic guppies cannot be cut up without killing them, how can the three sons fairly divide the guppies?

3. A refrigerator is placed in a completely airtight and perfectly insulated room. The door is opened and it is turned on. Will the temperature of the room drop, remain the same, or rise?

4. In many video games, it is possible to go off one side of the screen and appear on the other (such as in Asteroids). What kind of mathematical object (ignoring distortion) would the screen be?

5. Is it possible to blow soap bubbles in outer space? ■

--Tani Chen

Employment Expo

The Technograph, being an engineering magazine, covers events sponsored by the College of Engineering. Which is why, on September 7th of this Fall, I decided to frequent the Student Union, to check out the Engineering Exposition.

As I walked in, I initially felt somewhat out of place. I had stopped by in between classes, wearing my standard wash-n-wear attire of t-shirt and shorts, and I was surrounded by many well-dressed students sporting suits, ties and skirts. But I soon realized that actually there were others like myself, non-senior students who were just there to check out the scene and to begin to get an idea of what the job world has to offer. Many of the seniors, however, were there to turn in resumes and to make a favorable impression with the companies of their choice. The overall atmosphere was not too formal. Companies were there to recruit by answering student's questions and to show what they had to offer as a business. It is estimated that over 2000 students attended the fair. The Expo lasted from noon to 8:00 pm, and a reception was held at the Levi's Center afterward for company representatives, student hosts and the Deans.

The Engineering Exposition was the first central job fair sponsored by the entire College of Engineering as a whole. In past years, individual societies (SWE, ACM, IEEE, etc.) have held similar fairs on smaller scales. But frequently companies were asked to visit these smaller fairs on more than one occasion in one year. This being an inconvenience, corporate recruiters approached the Engineering Placement office and suggested an all-college affair.

The Exposition was a student organized project: the Chairperson was Stanleyned Macasieb, a senior in electrical engineering and the Executive Vice-President of Engineering Council. Organization of the Expo began in late February of 1989. Letters were sent out to 350 corporations, 72 attended. Companies from all over the country including DuPont, Dow, IBM, AT&T, Motorola, Intel Corporation, Caterpillar, and Lawrence Livermore National Laboratory participated.

The Engineering Exposition is planned to be an annual event in coming years. Students interested in participating in its production next year should contact Matt Murphy, Executive Vice-President of Engineering Council, in 300 Engineering Hall (333-3358). ■

--Minako Hashimoto

CUMUG

The October meeting of the Champaign-Urbana Macintosh User Group (CUMUG) will include a side by side comparison of Hewlett Packard's New Wave interface, a NeXT machine, and the Macintosh's own Multi-finder. Representatives from HP will demonstrate the New Wave software which is a graphical interface for the IBM PC and other compatible machines and a new generation operating system. It is extended beyond MS-DOS in many ways other than just the visual interface, such as allowing multi-tasking (the running of multiple programs at the same time) and linking between data from various programs. For example, a dynamic link would allow a word-processor to automatically have a chart from a spreadsheet program that automatically updates when the spread sheet is changed. Another purpose of this demonstration is to give the audience a chance to see first-hand the interface that caused Apple to sue HP last spring, though the case has not yet been completely resolved. In addition there will be a NeXT machine, the product from Steve Jobs' new company. Steve Jobs spearheaded the development of the Macintosh while he was still at Apple, and now he has produced a high-power UNIX work station with advanced windowing software.

There will be a Macintosh, as well as these two other interfaces, demonstrating that Apple's Multi-finder provides a much more precise framework to judge the differences between the interfaces and the software features.

Aside from the interface comparison, there will also be a question and answer session before the start of the meeting at 6:30 p.m., and there will be a software demonstration for Think's LightSpeed 4.0 C compiler with object oriented extensions.

All CUMUG meetings are the second Wednesday of each month at 7:00 p.m. in 304 Lincoln Hall. This semester's meetings are October 11, November 8, and December 6. ■

--Robert Frank

TechTeaser Answers

1. Strengths. (as in strengths and weaknesses)

2. Add one normal guppy to the pool. That makes the total 24 guppies. Then the eldest son will receive 12 guppies, the middle son will receive 8 guppies and the youngest will receive 4 guppies. 12 + 8 + 3 = 23. So the extra guppy is removed.

3. Rise. The refrigerator continuously tries to lower the temperature inside the refrigerator, and the heat removed is pumped outside by the Law of Conservation of Matter-Energy. In an ideal situation, the temperature of the room would remain constant, however, the motor of the refrigerator also produces heat due to friction which would eventually cause a rise in temperature.

4. A torus. On a plane it is possible only to keep traveling in one direction towards infinity. To visualize the torus, imagine "rolling" the screen so that the top touches the bottom. Then "stretch" it around the tube into a torus. (This is ignoring distortion of course.)

5. No. A bubble is formed because the pressure inside it equals the outside pressure. Since there is almost no air in outer space, any bubbles blown there would explode.

U.S. in Engineering Crisis

Planetary and lunar exploration, the perfection of organ transplants and the computer chip all represent some of the greatest achievements of American scientists. For decades, the United States has led the world in research and technology, but whether this trend will continue into the 1990's and beyond seems uncertain. The U.S. is faced with an engineering shortage in all fields of concentration. The number of graduating of physicists, chemists, mathematicians is also on the decline. If this trend continues, the dominant position in aerospace and other engineering related manufacturing industries held by the U.S. may falter.

The reduction in engineering graduates was preceded by a period of intense growth between 1977 and 1987. During this time, science related bachelor degrees practically doubled, and more importantly for the U.S. aerospace and defense related industries, degrees in engineering concentrations increased by an even greater degree.

The Engineering Manpower Commission of the American Association of Engineering Societies computed percentages of engineering degrees earned from 1977 to 1987 and found that the average number of computer engineering graduates increased by 300%, aerospace degrees increased by 200%, industrial and manufacturing engineering by 150%, mechanical engineering degrees by 100%, and materials and metallurgical engineering degrees by 45%. The enrollment of aerospace engineers has increased from 1986 to 1987 along with the enrollment of electrical engineers while mechanical, industrial, and materials/metallurgical engineering enrollment were on the decline and computer engineering enrollment remained steady.

At the University of Illinois the enrollment of aeronautical engineers seems to follow the same trend. Last year the University had to decline 65 surplus aero applicants from

admittance to the College of Engineering. Overall, aeronautical engineers represent only 4% of all engineers employed, however, the number of aeronautical engineering degrees granted has been increasing at a faster rate than most other engineering disciplines in the past ten years.

What are the reasons for the overall decline in engineering enrollment? Perhaps a look through the undergraduate course catalog can shed some light upon this subject. The curricula for engineering students seem formidable. Earning an engineering degree requires dedication and discipline in studying habits. Many students feel that the high salaries of engineering graduates cannot compensate for the rugged academia that must be endured. Another possible reason for the decrease in engineering enrollment percentages, compared to previous years, may be due to the decreases in college age Americans 18-22 years of age, the main source of engineering groups. The enrollment rate of women has also decreased from previous years. According to the Engineering Manpower Commission, the retention rate of women enrolled in engineering has dropped from 17% in 1983 to a present 14%.

The result of this decline in engineering students could be a critical lack of U.S. scientists in a world that is becoming increasingly dependent on advances in technology. By the year 2000, it is estimated the U.S. will require between 450,000 and 750,000 additional chemists, biologists, physicists, and engineers than colleges are expected to produce. Unless something is done to stop this oncoming shortage, there is the distinct possibility that America will fall behind other countries in the race for technological superiority. ■

--Elizabeth Peszynski

Illinois Winter 1989 Volume 105, Issue 2

Technograph

FRACtALS: A Descent into Chaos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Editorial

"I hate broccoli."

This statement began our high school's valedictorian's commencement speech, and strangely enough, it still seems to apply to the University of Illinois. How? This statement summarizes the number one thought on most college students' minds... well, maybe the number two thing... FOOD!

Food is inescapably essential to life and also seems to raise some important social issues such as botulism, salmonella poisoning, anorexia and bulemia, and pesticide use on food. Some of these issues often make headlines such as "Demon Toast Possesses Housewife" or on a more normal track "Americans are the Most Overweight People in the World." Anyway you look at it, though, food is central in man's thought and to his survival.

In the dorms, "late night study snacks" are an integral part of finals week, and the Domino's man is a regular in the lobby.

Both campus organizations and corporate recruiters have capitalized on students' fixation with food by offering food at their meetings. Many a rookie recruiter has found his information session empty due to lack of appropriate refreshments while a more experienced competitor is speaking to a full house next door due to his better equipped pizza budget. There are also some engineering societies that offer pizza after every meeting as a lure to members. Food-offering societies often find their meetings packed while non-food-offering societies usually proceeed with at most seven individuals.

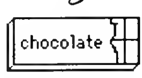
Food seems to provide one of the greatest incentives to students to get involved. In attending informational meetings and regular club meetings, these students will be fed for free. However, this use of food as a lure also brings up an important point. If these organizations feel it is necessary to lure people to their meeting with the promise of a food reward, it may be that their society does not promote activities that are of interest to students. The answer to their attendance problem then does not lie in serving food at their meetings but rather in changing the goals of the society to ones that will make students want to become involved.

Scientists offer food rewards to their laboratory rats to motivate them to perform a desired task. Societies offer pizza to motivate students to attend their meetings. Perhaps the key to unlocking students' minds lies in food rather than knowledge. Hence it would probably be beneficial if food were offered at all lectures (especially at tests).

A candy bar may be found somewhere in this magazine.

Eat and Be Merry,

Chi-Ting Huang



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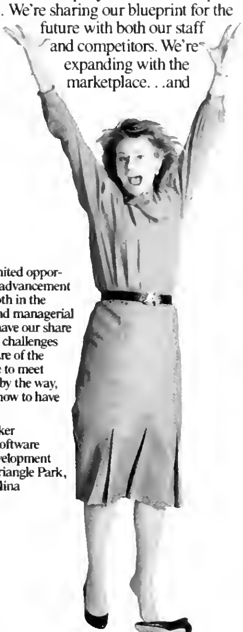

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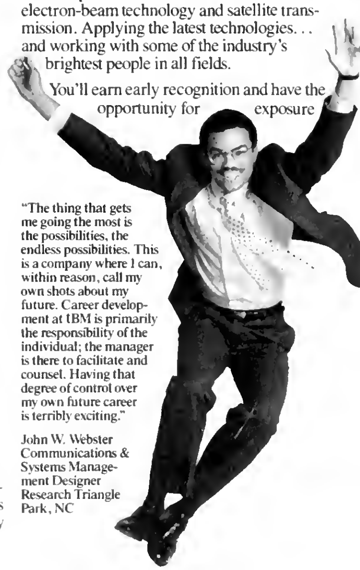

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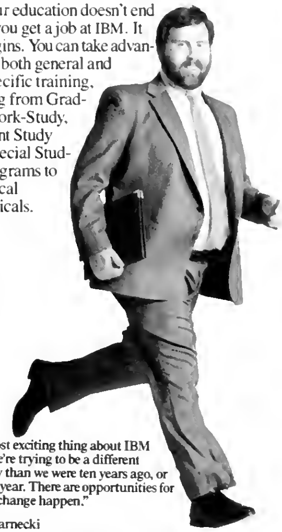

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Bioenvironmental Engineering

New organisms are constantly being developed and improved with the acceleration of biotechnology. Researchers have defined engineering of the exotic environments needed to support such forms of life within a building or room "bioenvironmental engineering." Bioenvironmental engineering is used to design a system for growing plants in space, or a method of increasing the production of food indoors. Because it is such a creative, complicated science, bioenvironmental engineering involves many diverse areas of research.

The research by plant scientists to maximize plant growth, for example, involves determining what environmental conditions are best for a given species of plant at a certain stage of its growth. For such research collaboration between the Plant Science Department and Engineering Department is necessary to determine and control the experimental environment. For example, at the University of Illinois, Dr. Sharon Knight of the Plant Science Department is working with Dr. Leslie Christianson of Agricultural Engineering and Dr. Roy Crawford of Mechanical Engineering to determine the effects of air velocity on plant growth. Variations of air velocity affect the exchange of carbon dioxide and oxygen in a leaf which in turn affects plant development. The optimal air velocity for growth is under investigation.

Dr. Christianson, Dr. Crawford, and Dr. Knight are now working to build a growth chamber for this experiment (a refrigerator sized device in which plants can be grown and environmental conditions carefully controlled.) This growth chamber will be designed to set and monitor air velocity and motion over the plants. With such precise control of the environment, much information can be learned about how plant growth can be most enhanced by air velocity.

The engineering used to produce such an environment involves three major areas: measurement and evaluation of heating, ventilation, and air conditioning equipment available on the market; the implementation and development of sensors and controls; and an understanding of air movement in the environment.

Across the country many types of ventilation and heating equipment are tested. The data from these tests will answer the engineering question, "How do you transform a theoretical design into a real building or room and retain a system that still behaves like the theoretical model?" Dr. Christianson constructed a fan test chamber in 1987 for evaluation and measurement of ventilating equipment. This chamber is used for testing and evaluating ventilation fans used in the livestock and greenhouse industry and gives information on the quantity of air that the fan will move against a given

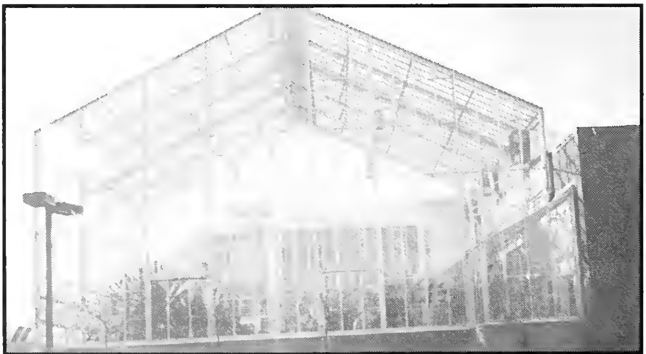


photo by Julie Reyer

Plant experiments are performed all year round at the U of I.

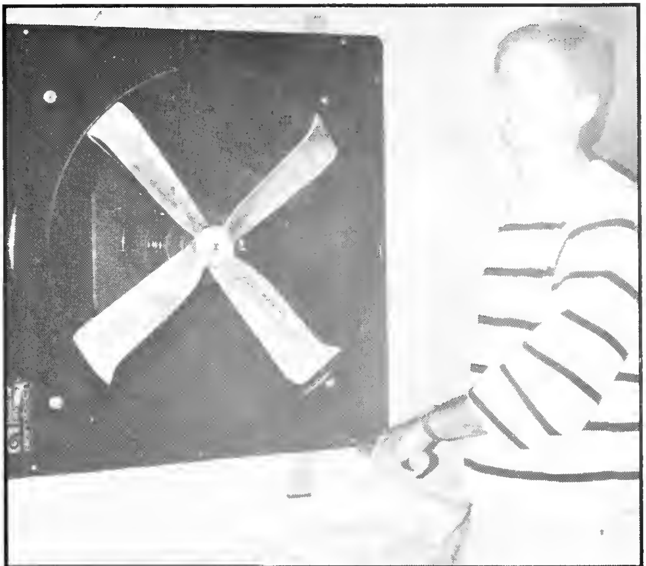


photo by Julie Reyer

An agriculture student tests a ventilating fan on Dr. Christianson's fan test chamber.

pressure and the amount of electricity that it would require to move that quantity of air. These data can be applied in engineering to aid in the choice of fans for a designed building or room.

The environment must be maintained with a great deal of precision if plant or animal growth is to be accurately analyzed. Environmental systems, no matter how sophisticated, are limited in accuracy to the precision of the sensors which give information about the condition of the environment. Though the measurement of very low air velocity can be accomplished with very expensive equipment, the accuracy of the measurement is still questionable. Hence there is a great demand for an accurate, low-cost low velocity sensor. Development of sensors that will last for many years in strictly controlled environments is another motivation for constant improvements to sensors and sensing methods.

In the past, the movement of the air was measured in a greenhouse or livestock building and changes in the equipment were made to match the actual air currents to the preferred motions. But now, the size and shape of most green houses and livestock buildings are different than those designed in the past. This means that the air movement in these new buildings must be redetermined. To do this, an engineer would need to consider mathematical models of air currents in the design of a new building to assure that the ventilation system would perform as desired. These mathematical model predictions are atill in their infancy. Much of the work on these models has been done at the University of Tennessee. Dr. Christianson would like to test their mathematical models by building models of buildings of different sizes and shapes and measuring the air movement in them. Comparing these data to the results derived from the mathematical models will either confirm the accuracy of the mathematical models accuracy or lead to an alteration of the models.

The ultimate result of all areas of bioenvironmental engineering research is that an engineer can, given knowledge of what type of plant is grown and its needs, design a building or room which will provide the correct environment. The system size and shape can be determined, and through the use of the mathematical models of air movement, the theoretical capacity shape and location of the equipment can be found. Comparing these theoretical values with values from equipment test data, the correct equipment for the system can be chosen. Finally, the sensor and controls can be added to the system which will result in the proper system control necessary to keep the environment at the correct setting for maximum plant or animal growth. This is how a complete system, which will provide for maximum plant growth, is "bioenvironmentally engineered." ■

--Bill Hughes

Aerospace Technology

Original ideas and the initiative to build these ideas into reality has jettisoned technology to the far reaches and beyond. Engineers and scientists are working together to advance the aviation and space industry. Two projects have recently hit the news: the B-2 stealth bomber and NASA's National Aero-Space Plane. The B-2 has come off the drawing board as a full-scale working prototype. Although the defense department has succeeded in draping the bomber in secrecy, reports concerning the modern "flying wing" have been released to the public. Now in the public eye, controversy has engulfed the fledgling prgram. The stealth bomber far exceeds its estimated total cost; Congress is questioning it's worth and considering cancelling the program altogether. However, other administrators have voted in favor of funding the program because of the B-2's advantages in warfare.

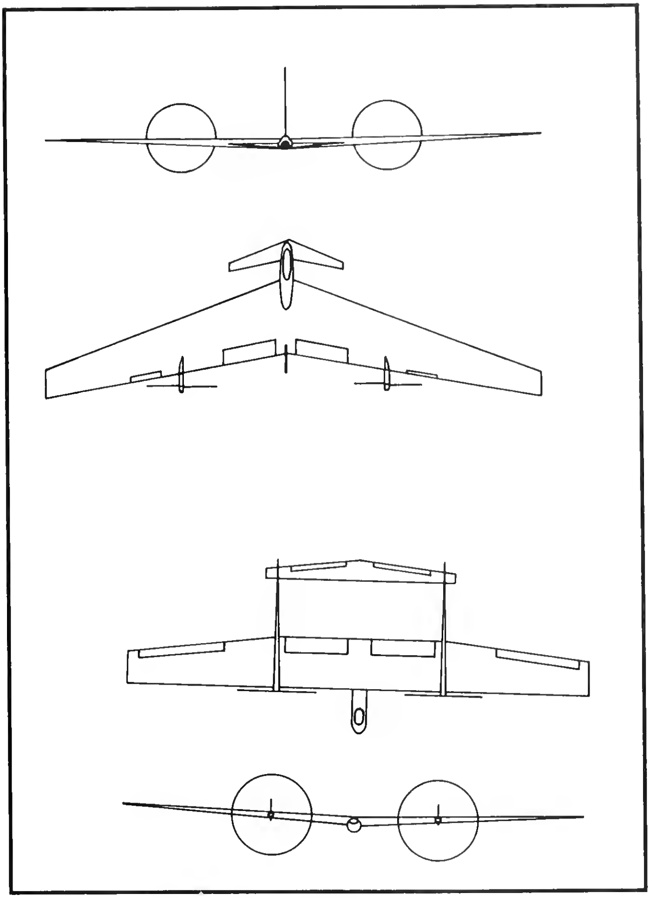
The high-tech flying machine is a flying wing configuration with no vertical surfaces in order to reduce enemy radar detection. The cooling system on board aids in reduced infra-red detection. This particular aerodynamic structure is subsonic with a ceiling of 50,000 feet. The airplane flies with a reported lift-to-drag ratio of 24, compared to 9-18 for other types of aircraft. This is due to its lightweight frame and its even weight distribution. It's maximum payload is enough to carry sixteen nuclear bombs or eighty conventional 500 pound bombs.

All the positive attributes of the B-2 have been highlighted, but its purpose has not been emphasized. Essentially, the B-2 is a major defense weapon against nuclear attack. The defense department has come up with a way to build a better bomber. "The rationale is that the Soviets would never risk a first strike if they were convinced that the B-2 would come in afterward and destroy its reserve mobile forces and the bunkers housing the military and civilian leaders," reported the journal, Popular Science.

photo by Chris Guy

Future aerospace engineers hard at work in the lab at U of I.

The space plane serves a more practical purpose than the B-2 in that it can be used as a cargo carrier for space satellites and space stations. One of the issues with which researchers are faced is finding a propulsion unit that will allow the plane to fly as fast as Mach 8, which is approximately eight times the speed of sound. The plane will also have to be constructed of materials that can withstand stresses at 3000 degrees Fahrenheit. The space plane is argues to be cheaper to maintain in comparison to the space shuttle, and will be able to take off and land from any airport. Its weight will be one-tenth the shuttle's weight and its payload will be about half that of the shuttle. Researchers say the plane will only require 100 people to service it, versus

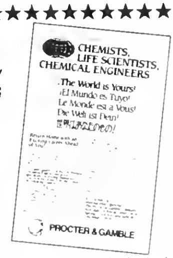


Drawing of proposed designs of the Marsplane .

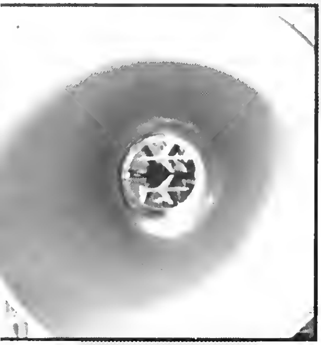
the shuttle's 15,000 people. The research and development for the construction of the plane has been estimated to be five billion dollars. Five companies have been contracted to complete the space plane by 1997.

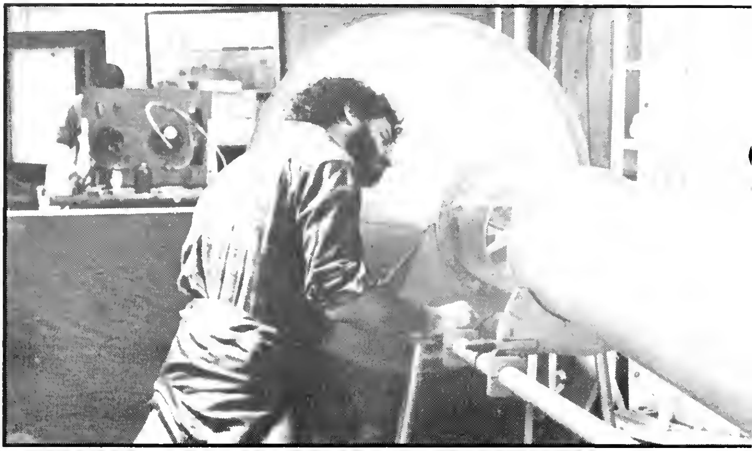
While Congress ponders over whether or not to continue funding projects such as the B-2 and the space plane, engineers around the world will be working to provide the technology of the future. The University of Illinois' Aeronautical Engineering program shapes the minds of future enterprising engineers by providing a well-rounded curriculum and a highly capable faculty. The four-year undergraduate program includes classes such as Aerospace Dynamic Systems, Aircraft Propulsion and Flight Vehicle Design. These classes cover flight and stability control, the fundamentals of propulsive devices and the preliminary design of airplanes, missiles and space vehicles, among other areas. The required courses train aspiring aeronautical engineers to think analytically in order to handle the problems that may arise while dealing with various aerospace systems. The knowledge gained from these and other advanced courses gives aeroengineers a strong foundation for participation in projects such as the design and construction of the B-2 or the space plane. Hopefully the fruition of their dreams in science will enrich many lives in the future. ■

--Joy Vallesterol

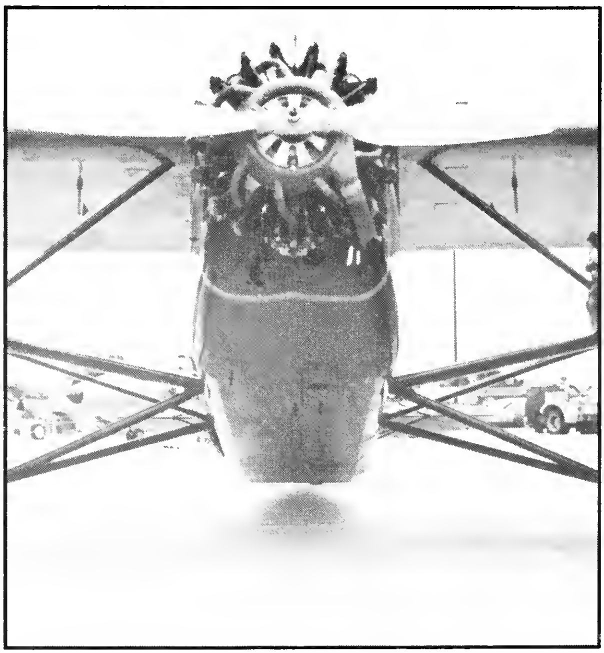


FROM THE DRAWING BOARD...



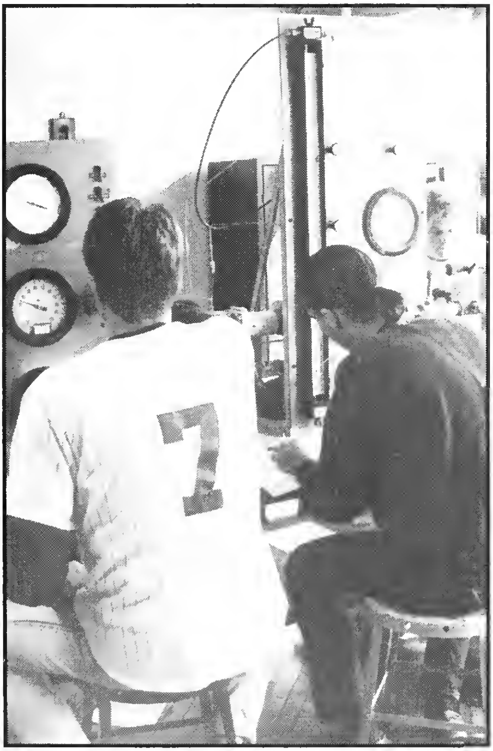


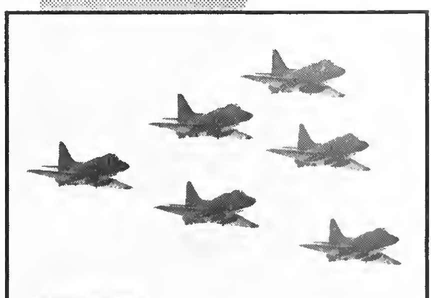
THROUGH THE SKIES...



AND

MAN AND FLIGHT





INTO THE HEAVENS ...

Photos by Chris Guy

Fractals: A Descent Into Chaos

"Fractals" is the name of a concept that has existed for quite a while, but is very hard to define. Originally, the word was coined from the words fractional dimension. However, this does not even begin to describe the concept of a fractal. Many mathematicians, physicists, and other scientists continue to disagree on the precise definition of a fractal. The term, fractals, in fact has many different definitions. One definition relies on the process that generates a fractal. Another definition stresses their property of being self-similar. Yet another definition uses the concept of the "fractional dimension" from which the term was derived(as opposed to a whole number dimension). Various other definitions stress other aspects of fractals (1). One important distinction that can be made about fractals is that the word "fractals" is generally used for the more mathematical side while the word "chaos" is used for the more scientific side; however, the two terms are very closely related.

Scientists and mathematicians continually disagree on the definition of a fractal. Some of the mathematical objects which are being debated as fractals are the cube, the square, the line, the point, the Mandelbrot Set, the Julia set, a dragon curve, and even such commonplace objects as forest fires and snowflakes (1, 2). These objects may or may not be fractals depending on the definition used and who is answering the question.

The fractal originated from an application of Newton's Method. Newton's Method is an algorithm which can be used to find the roots of a function. This method will not only find the real roots, but also the complex roots as well such as in the equation:

$$x^2 + 1 = 0$$

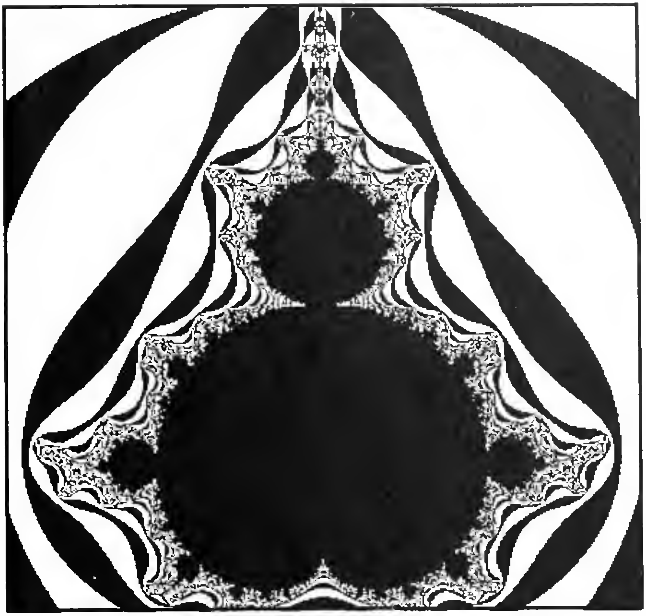
A complex number is defined to have a real number part and an imaginary part. The imaginary part consists of a multiple of i where $i \sqrt{-1}$. Newton's Method can be defined to be:

$$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)}$$

where x_1 is some initial guessed value which can be real or complex. The limit if these successively approximated values is a root of the equation. To find a different root, a different initial value is used. Usually the root found is the root closest to the initial guessed value (3). However, in some instances this is not the case. Some initial values will approach a different root other than the closest one. Other initial values will not approach any root at all, but will cycle through a series of numbers. All of these initial values can be plotted onto the complex phase and are sometimes colored accordingly to the root it approaches. Usually this is done with a computer, to quickly generate a large number of distinct points. In analyzing these computer-generated pictures, one finds some interesting patterns. Near the roots of the equation, the surrounding points are attracted to that particular root. However, where the "attractions" of two or more roots approach each other, the boundary is not a line or a simple curve, as one might guess, but a complex region of interaction. These regions are called "fractals" and the idea of fractals originated from these regions between the different roots that were approximated by Newton's Method (1).

As one might guess, the study of fractals quickly expanded from Newton's Method to other different types of methods, some of which used the complex plane. The concept of fractals likewise expanded as new mathematical objects were discovered and studied. Currently, no one seems to agree on any one particular definition, but there appear to be three main definitions (1).

In general, the first definition depend on the process that generates that fractal. Nearly all fractals developed and studied arise from a "recursive" definition, or a definition where the value



No, this is not Number 3 from the Rorschach ink blot series on obsessive-compulsive behavior...this is a computer-generated Mandelbrot set.

photo by Julie Reyer

Many objects in nature are fractals, leaves are one example.

of a certain function relies on the value of the previous one. For example, in Newton's Method, the next successive value, x_{k+1}, is calculated by using the previous value, x_k. Many other fractals use a geometric recursive procedure, or some other different recursive mathematical algorithm, some of which use the complex number plane (1).

A second definition is that most fractals are "self-similar," meaning that a part of the fractal look similar to the whole fractal. This tends to be a vague concept since in some cases, the smaller self-similar parts are only slightly mathematically similar to the whole object. The Mandelbrot Set is a good example of this concept(1).

One other definition uses the concept of a "fractional dimension." It is known from geometry that a line has one dimension, a plane two dimensions, and space three dimensions. The concept of fractional dimensions states that a mathematical object may have a dimension that is not a whole number (e.g. a dimension of 2.548).

These three definitions are rather vague and indefinite, and even though the study of fractals is a rapidly growing field, an overall definition may still be years away.

In current technology, however, fractals are finding wide applications and many more applications may open up in the future. Much of these application have been given the term "chaos" or "chaos theory." In medicine, chaos theory is being used to examine the pattern of heart fibrillations in order to understand them better and prevent their occurrence. Chaos theory also predicts that weather prediction is impossible much to the dismay of many meteorologists. Fractals can also be used to reduce movies onto a smaller film. In fact, fractals are being used a large variety of fields ranging from medicine and geography to meteorology, chemistry and metallurgy.

The research into Newton's Method was the catalyst that spawned the field of fractals, but much of this study could not have been developed without the aid of computers, which were used to calculate the values of Newton's Method at every single point. Before the use of computers, much of this research would have been nearly impossible, since it would take much more time to calculate these individual values, even with the aid of a slide rule or a calculator. Ironically, it is the very use of tools such as the computer

continued from p. 11

or calculator that causes some scientists to reject the concept of fractals. These people felt that a computer, along with calculators and slide rules, should never be used in mathematics since none of these tools can be completely precise. For example, a representation of the fraction 1/3 on a computer will always be incorrect. Additionally, these scientists also felt that fractals have little to do with the rest of the well-established body of mathematics.

The field of fractals continues to grow and expand despite a lot of speculation and criticism both inside and outside of mathematics and science. It seems likely that in the future, fractals will become an important branch of mathematics.

At the University of Illinois, there are several professors working on chaos and fractals across campus. Among them are H. Benzinger in the Department of Mathematics, E. A. Jackson in the Department of Physics, and A. Hubler and N. Packard at the Center for Complex Systems Research at the Beckmann Institute.

A special thanks goes to Harold E. Benzinger for his ideas and support. ■

--Tani Chen

ENDNOTES

1. Personal interview with Professor Harold E. Benzinger, Department of Mathematics - University of Illinois, Urbana. October 28, 1989.

2. Ivars Peterson. *The Mathmatical Tourist: Snapshots of Modern Mathematics.* New York: W. H. Freeman and Company, 1988.

3. C. H. Edwards, Jr. and David E. Penny. *Calculus and Analytical Geometry*, 2nd edition. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1986.

Q: TECHTEASERS

1. A certain school has 2000 lockers and 2000 students. The first student goes through the school and opens every single locker. The second student goes through and closes every other locker. The third student goes through and reverses every third locker; i.e. if it is closed, he opens it, and if it is open, he closes it. The fourth student goes through and reverses every fourth locker, and so on, until all 2000 students have gone through. How many lockers are open, and how are they ordered?

2. You are given 9 identical widgets. All widgets weigh exactly the same. However, there is an imposter in their midst. It is known that the imposter will be slightly heavier. You are given a two pan balance. What is the minimum number of weighings required to determine the imposter?

3. Engineer Bob has three daughters. College Joe wants to know what the ages of his three daughters are.
Engineer Bob says, "The product of my daughters ages is 72."
College Joe says, "That is not enough information."
Engineer Bob then says, "The sum of my daughters ages is on my mailbox."
College Joe says, "That still is not enough information."
Engineer Bob says, "My eldest daughter likes apple pie."
What are the ages of the three daughters?

4. What does "2Se. - 7Pri. + 6N. aequator 0" mean? What's the answer?

A:

1. *44. #1, 4, 9, 16... 1936. Only perfect squares have an odd number of factors (16: 1, 2, 4, 8, 16) while others numbers have an even number of factors (18: 1, 2, 3, 6, 9, 18), so only perfect squared numbered lockers would remain open.*

2. *Two. Divide the widgets into sets of three. Weigh two sets of three on the balance. The heavier set contain the imposter. If both set are equal, the odd set out contain the imposter. Within the set weigh two of the individuals. Once again, the heavier widget is the imposter. If both widgets are of equal weight, the odd widget out is the imposter.*

3. *8, 3, and 3. For the set of factors of 72, each combination has a unique sum except for the combinations 8, 3, 3 and 6, 6, 2. If the number on the mailbox were one of the unique sums, the ages would be known. Since the College Joe cannot figure out the ages from the number on the mailbox, it must be one of the two sets stated above. Engineer Bob's eldest daughter likes apple pie; hence, he has only one eldest daughter. Therefore the correct combination is 8, 3, 3.*

4. *$2x^2 - 7x + 6 = 0$. This is the notation mathematicians used during the fifteenth and sixteenth centuries. The roots of this equation and 2 and 2/3.*

--Tani Chen

The Latest In Gourmet: Food Engineering

Food Engineering. You may have heard about it recently from the publicity given to Orville Reddenbacher's donation to the University of Illinois' College of Agriculture. Food engineers are going to use this donation to research how to obtain greater volumes of popcorn. But what are food engineers? What do they do? Food engineers use engineering and scientific principles to improve the preservation, production, and processing of foods. The food industry is the largest industry in the United States. Food processing and related industries account for about one fifth of the nation's gross national product. Technological developments in this industry have created the need for professionals with technical skills. The food engineering program at University of Illinois is fairly new. Although food engineering has only been offered as a major for four years now, the greater demand for food engineers has resulted in the option of food engineering as a minor.

A degree in food engineering was first offered as a major in 1985. The program was started by Dr. Emol Rodda and Professor Marvin P. Steinberg who are professors in Agricultural Engineering. Food engineers use their technical and scientific skills to process foods. There are four aspects of food engineering: process design, equipment design, instrumentation of controls for the processes, and facility design. Process design involves designing entire systems to either preserve, process, or produce foods. Equipment design requires making advanced equipment to implement a certain process by using new technology. Food engineers also need to design instrumentation to control operations of food precesses. Finally, food engineering involves designing entire food processing facilities. These four categories require both engineering and food systems knowledge to implement.

There are three methods to obtain a food engineering degree. One method is through the Department of Agricultural Engineering four year program. This requires completion of general engineering and science courses like food chemistry, food microbiology, and thermodynamics. In addition, there is academic training which includes laboratory courses. These laboratory assignments include designing unit operation and food processes. In advanced courses, students are even able to design food processing plants.

The second method of obtaining a food engineering degree is through a five year program which enables students to earn undergraduate degrees in both engineering and agriculture. It only requires an additional thirty semester hours of agricultural courses.

Finally, the Department of Food Science has a food industry curriculum which emphasizes engineering. Thirty-three semester hours of food science courses and fifteen hours of food science courses and fifteen hours of engineering courses are required.

The Department of Agricultural Engineering is hoping to offer food engineering as a minor this spring semester. Students can receive a Bachelor's degree in Engineering and a minor in Food and Process Engineering. The requirements for the minor are eleven semester hours of required courses like Food Microbiology and Food Engineering. Also, an additional four hours of technical electives. Finally, an internship is required. It is automatically guaranteed to all students enrolled and the internship also counts as one semester hour. This internship provides financial support and valuable work experience. The courses taken for the minor can be applied as electives in the student's major.

Besides undergraduate degrees, the Departments of Agricultural and Food Science also offer Master's and Doctoral degrees in food engineering. Food engineers

have high entry salaries. With a bachelor's degree, entry-level salaries average $30,000. With a master's degree, salaries are about $35,000, and a Ph.D salary begins around $45,000.

The work opportunities for food engineers is growing. Since the food industry is the largest industry in the U.S., there is a high demand for food specialists with technical knowledge. Food engineers usually work for companies that process and preserve foods, chemical and pharmaceutical companies, and government agencies. Besides having a wide job market, food engineers have great opportunities for advancement. Food engineers can work as production supervisors and managers of companies, in research and development, and in technical sales. Furthermore, it is projected that there will be a 22% increase in the number of engineers employed by a hundred of the largest food companies by 1992.

Food engineering is growing rapidly at University of Illinois since its start in 1985. The Department is expanding and will be providing the option of taking food engineering as a minor as well as a major. The wide job market and future job opportunities provide a great incentive for students to enter this field. For further information about food engineering contact J. Bruce Litchfield at the Department of Agricultural Engineering, phone 333-9525.■

--Bhavini Patel

Techprofiles: Robert E. Miller

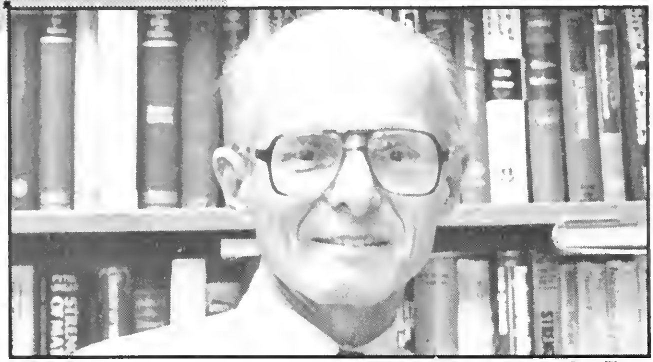


photo by Dean Wagner

Inspired by building and flying model airplanes in his youth, Robert E. Miller, a professor and advisor in the University of Illinois'

Department of Theoretical and Applied Mechanics, has dedicated almost forty years of his life studying, researching and teaching such related topics as statics, dynamics, solid and fluid mechanics and numerical methods.

Smiling with reminiscence, Miller recollected his memories of the fifties during a personal interview. The current professor of TAM 221 launched his college career here at the University of Illinois. Majoring in Aeronautical Engineering as an undergraduate, he received his Bachelor of Science degree then he concentrated his studies in TAM, where he was rewarded with a M.S. and Ph.D.. "I've always enjoyed flying model planes, but I never intended to teach.", Miller recalls. "The deciding factor for my staying as a professor was that I really liked teaching when I worked as a T.A.,", he explains, "and I never get bored since it's always a new group of students and fresh faces every semester." Miller taught courses in elementary mechanics while earning his masters and doctors degrees here at the University.

> "I do, at times, get students who complain that the program isn't challenging enough!"

The advisor of both undergraduate and graduate students continued, "If I had to choose, my favorite class to teach would be TAM 416." Miller prefers smaller classes where he is more accessible to students for interaction during class than large lectures. TAM 416 is a "good size" graduate class on energy methods in mechanics with "a lot of interesting and applied problems." He notes that students often do not pose questions during big lectures because they get intimidated by the size of the class.

When asked to compare today's engineering students to those of the fifties when he was a student himself, Miller, who describes himself as old-fashioned, acknowledges that, "On the positive side, the present students' academic potentials are higher since the entrance requirements have toughened throughout the years. But he also notes that, "On the negative side, I've detected less motivation from the kids." It seems to him that students today are not working at the peak of their performance levels. According to Miller, this phenomenon could be accredited to the impersonal nature of big classes, which often leads to poor class attendance. "I strongly encourage students to come in and talk with me," Miller said, "but I only get to know the few that come back consistently." The TAM professor holds regular office hours at 111B Talbot Lab.

Miller has been a Champaign-Urbana resident since beginning teaching in 1955. Still single, he enjoys jogging, reading, golfing and of course, and flying model airplanes when he's not busy with class work. Miller has

done research in the area of solid mechanics, more specifically, finite elements. This involves the dividing of complicated structures into parts, and then using simple analysis of each piece to get and overall picture for the study of the problem. His present research project concerns finite elements for composite structures.

This serious leisure golfer and jogger intends to continue teaching here until retirement. He said, "Champaign-Urbana is not a bad community to live in; it's good for at least two-thirds of the year." Professor Miller concluded the interview by praising the excellent Engineering curriculum at the University. He left us with this quote, "I do, at times, get students who complain that the program isn't challenging enough!" And we will leave this to your imagination." Professor Miller concluded the interview by praising the excellent Engineering curriculum at the University. ■

--*Judy Hsu*

Spreading Viruses: The New Common Cold

As the turn of the century approaches, many people will let their minds wander into the future, where anything is possible... a cure for AIDS, fusion power, or a way to reduce sleep requirements for those late night study vigils. Computer scientists, however, will look ahead wishing for one thing— a cure to the potential scourge of computer viruses which will likely plague computers and computer networks for years to come.

The computer virus earned its name for its remarkable similarities to its biological counterpart. The virus is a program which attaches itself to another program or disk. The first purpose of the virus is generally to spread as widely as possible before it activates itself. This generally includes copying itself to hard disks and any disks placed in the floppy drives, attaching itself to individual programs which may be uploaded to bulletin boards or other electronic networks, or seeking out terminals on a network to infect. Although this is the technical description of a virus, the term has been used to describe a variety of other programs which accomplish similar goals in vastly different ways.

The trojan horse is one example. This infection differs from a virus in the respect that it is a complete program which appears to have a different use. Where a virus could attach itself to any program, the trojan horse acts as a stand-alone program. A trojan horse could be disguised as a useful utility program, a game, an application, or any other conceivable computer program. The trojan horse depends completely upon where the program is distributed for its range of infection. The program could be widely distributed by electronic bulletin board systems, national networks such as CompuServe or Delphi, or by hand. Once these programs are run on a system, they may reveal their real purpose.

Another example of a common computer infestation is the worm. The worm acts much like a virus in the respect that it deliberately spreads itself, but it is a program in itself rather than a set of subroutines attached to another program like the virus. The worm is most common on a computer network where it can spread itself from terminal to terminal as discretely as possible. Because the network allows the worm to spread by itself, it does not need a "host" program to which to cling like the virus.

The purpose of these infestations generally depends upon the goals of their programmers. Sometimes virus programmers have a specific intent. Disgruntled employees have been known to release viruses into their employer's computer systems to be activated a couple of days after their termination. Viruses have excellent utility where espionage and terrorism is concerned. If a virus infiltrated computers in any country's defense installations, they could paralyze national defenses in a blink of an eye with no warning whatsoever. Viruses could also be used for corporate sabotage as well as extortion and a number of other felonies.

Many programmers release viruses out of malicious intent or pure pride, however. Some of these viruses pose a tangible threat to personal computer users. The viruses have been known to be relatively benign, such as the "Christmas card virus." This virus was programmed by a West German student to send to his friends. The program was an innocent greetings card program, but it was designed to copy itself to other computers, classifying it as a virus. The virus eventually spread so far that, in December, 1987, it infected IBM Corporation's network, causing it to shut down its networks for three hours to disinfect its computer systems. The virus was designed to be benign, but it cost money in terms of computer down time and disinfection of computer systems. Viruses have also been known to be

extremely threatening, such as the recently publicized Friday the 13th, or Datacrime, virus. This virus stays completely dormant while it spreads itself to as many IBM compatible computers as possible until it finds itself on a computer where the internal clock is set on any Friday the 13th. When the computer is booted up on that day, it systematically destroys all accessible files. Many viruses are even more dangerous by not causing outright mass destruction, but quietly corrupting files or singularly erasing files at large time intervals. If a person finds a single files corrupted or erased, he/she may think that it was simply human error and never even consider that it was the work of a virus. Even worse, a user could use corrupted information for months before realizing that the files is erroneous. This could be especially disastrous with spreadsheet and database files, where previously entered information may be seldom proofread and present and future statistics may rely on information garbled by a virus.

The computer virus is said to have its roots in a work of science fiction written by John Brunner called Shockwave Rider. In this book, the hero detains a computer by writing a worm to occupy it. In fact, Robert T. Morrison, Jr., the man who programmed the worm which upset the ArpaNet and MilNet systems in November of 1988, had a copy of this book which had been read so many times that it was nearly in pieces. This book and others like it which have followed have inspired some computer programmers to live out their fantasies in a world in which the computer programmer commands ultimate power and hires his services out like a mercenary to the highest bidders. In fact, the motivation to many viruses can be traced back to fantasy fulfillment.

Eugene Spafford was quoted as saying, "The only truly secure system is one that is powered off, cast in a block of concrete and sealed in a lead-lined room with armed guards—and even then I have my doubts." There are certainly more feasible ways of protecting personal computers, although none may be quite as effective. As most of the viruses written have been for the Macintosh and IBM computers, most other users need not worry. There are several for the Commodore Amiga and the Atari ST, although they are not extremely widespread.

The first and main line defense against viruses should be prevention. Users should carefully choose where they get their software. Public software is by far the most common target. This software can be passed by hand or over any electronic network. Simply borrowing software from a friend can transmit a virus. The best source for uncontaminated software is commercial, shrink-wrap software. Safe software may be obtained from reputable dealers and distributors who carefully screen their products.

Users should watch for any strange computer behavior which may be attributed to a virus. Some symptoms include a screen which blanks out or acts strangely, disk access when there should be none, a definite slowing of computer processes, and an unusual reduction in free memory. Finally, many commercial virus detecting and removal programs are available, although they can generally only detect known or fairly unsophisticated viruses. Even so, frequent usage of such programs is definitely recommended by experts. It is also wise to have back-ups for all important data, in event of total loss of disk or hard-drive memory due to a virus.

Although viruses do not present an optimistic view of the future, they are certain to play a part in it. Whether they play a major role or a minor one will depend largely on not only the programmers who combat this menace, but also on deterrence of the criminals by those who can impose penalties on them. ■

--John Fultz

Profiles: Campus Honors Program

Universities make an effort to provide opportunities for students which best meet their academic and professional goals. Many of these opportunities take the form of special programs created to expose students to people and ideas that may otherwise have been inaccessible to them. The University of Illinois Campus Honors Program (CHP) is a program geared toward oustanding students and introduces them to a wide variety of disciplines and people. The CHP consists of four hundred students, one hundred from each year, that are chosen as incoming freshmen on the basis of academic achievement and interest in gaining a rounded education. In the interest of keeping the program diverse, each class has representatives from all of the colleges at the university. Upon graduation, those students in the the program have completed a set of requirements, including special coursework and extracurricular activities, which aims to provide them with a broad educational background.

The classes offered through the program are either special sections of classes that already exist or sometimes classes that are created exclusively for the program. By and large, the latter is the result of professorial interest in teaching a course that directly relates to a topic of interest to him, and the program provides a context in which he can create such a class. Most of the classes deal with the humanities and social science due to the fact that it is difficult to offer any upper level technical classes to a group that represents so diverse a group. All of the classes are acceptable for use in fulfilling general education requirements, however, and are encouraged to be used as such. The main advantage of these courses is that they have a maximum class size of fifteen students, allowing for one-to-one interaction with the professor.

The lecture series called the "Scholar Adventurers Series" allows both University of Illinois faculty and outside speakers to come speak about their work to the members of the CHP. Topics range from technical and scientific, like a recent lecture on the applications of ultrasound, to the humanities and social sciences, like a lecture on changing views of the Vietnam War. Also, once a year an open convocation lecture is given by a well regarded lecturer invited by the CHP. The lectures provide an excellent opportunity for the students to meet and talk with people in all types of fields.

The CHP students are also offered dress rehearsal passes to a number of performances at Krannert Center for the Performing Arts. The Krannert Dress Rehearsal series, as it is called, allows students to attend rehearsals of plays, musicals, and operas. An introduction to the behind-the-scene production is usually given by the director.

Beyond the activities available to the students in the program, they are also assigned a professor in the university as a mentor to guide them in their studies. Students consult these advisors on topics ranging from simple class selections to determining the entire course of their studies at college. Some students have also found positions working with their mentors. The availability of these professors provides an excellent contact between students and some of the most knowledgeable people in their respective fields.

The CHP has a house which includes a small but growing library, PLATO terminals, computer labs, and lounges in which to study or relax.

The Campus Honors Program provides an excellent opportunity for students to make use of the resources available to them through their university. It opens doorways to extra experiences that can maximize their academic rewards while attending college. ■

--Kristin Ringland

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Bioengineering

Clean WATER

EDITORIAL

The first thing one might picture when thinking of a scientist is a pleasantly insane man with a shock of Einstein hair draped in a lab coat soaked with various cancerous chemicals working feverishly in a secluded laboratory towards some obscure goal that only he understands. Although some scientists today may still sport a stylish Einsteinian head of hair, the truth is that scientists today neither work alone nor are their goal obscure.

Here at the University of Illinois and many other universities, as well as in the corporate world, scientists are expected to work in teams on a goal of universal importance. However, in order to insure that their research is actually of some importance to the public, a scientist must know not only his own area of interest well, but also have a general knowledge of other areas of science. After all, if the scientist at DuPont was so oblivious to the world that he missed World War II, he would not have known that there was a need for a silk substitute and today nylon would just be a scientific curiosity.

Research is supposed to benefit everyone, not only those of a limited scientific community. The excitement Fleischman and Pons created with their announcement of the "discovery" of cold fusion and the heat generated as a result was not because scientists wanted to warm their hands around a test tube on those cold winter nights or even because they could boil water for their coffee faster, but because the cold fusion signified that energy (electricity) could be generated more cheaply and with less hazardous wastes that could benefit everyone. The application was seen to be more useful than in just heating up obscure reactions for chemists.

Especially in modern society, knowledge is power. Among engineers, this is becoming even more important. A commonly voiced complaint about scientists and engineers is that they do not have enough of a humanities background. However, it is not only humanities that are lacking, but knowledge in other sciences.

When students first come to the University of Illinois, they are herded into classrooms of 100+ students majoring in subjects varying from English to Electrical Engineering. As junior year approaches, however, these students are expected to become more specialized within their own major and consequently they end up in in smaller classes with people of similar majors.

Engineers are expected to know a lot about one particular subject due to the sheer volume of information to be digested, but in order for their knowledge to be most beneficially applied, they should also know about the developments in other areas of research. This is the reason for some of the interdisciplinary projects between departments. Knowledge between departments can be shared to achieve a common goal. Engineers should not only participate in these interdisciplinary projects but also try to take classes in areas other than their major, so that their contribution to society can be more than a scientific oddity. Rather it can be something to actually improve on the quality of life of all people not just those who want to heat up their coffee in lab.

Ju-Ting Huang

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The Latest In Atom Smashing

Experimental high-energy nuclear physics is a complicated branch of an often confusing science. Researchers in this field try to determine the fundamental forces of nature and answer the questions concerning the beginning of the universe and the construction of matter.

Experimenters from the University of Illinois at Urbana-Champaign are working in teams with other universities from this and other countries such as Japan and Italy in trying to discover a theoretical division of matter known as the "top quark". A quark is a composite of matter that is smaller than a proton. It is now considered to be one of the basic building blocks of matter, just as Aristotle believed the atom to be.

Most of this research is carried out at Fermi National Accelerator Laboratory located in Batavia, Illinois, currently the world's largest atom smasher. This is a large physics laboratory run by a conglomerate of universities for the purpose of investigating high-energy physics. The question which spurs this research is simply, "What do you get when you break apart the smallest pieces of matter you can find?" The answer is smaller pieces of matter.

This done by taking a hydrogen nucleus (a proton) and then accelerating it around a large ring while giving it electrical energy, and then smashing it into something. This something can either be a fixed target, usually some metal, or other accelerated particles, known as anti-protons. When this collision occurs, new particles are formed, and it is these particles in which researchers are interested. The University of Illinois Physics Department is currently working on an experiment known as the Collider Detector Facility (CDF) which in essence uses a very large microscope to detect various sorts of information such as the type and energy of the particles formed from proton-anti-proton collisions.

In the most recent run of experiments at CDF, (from June 1988 to June 1989), data was taken in search of the top quark. This is the last of a group of six quarks to be found. Quarks come in pairs- "up" and "down" quarks combine to give us normal matter such as protons and neutrons. The next generation, or pair, of quarks are known as the "charm" and "strange" quarks. These quarks have masses which are much greater than that of a proton and are only found in solar systems that are just developing and theoretically in the very early universe. They combine to give exotic types of matter not found in the earths natural environment. The last generation of quarks are the "top" and "bottom" (or "beauty") quarks. These quarks are much heavier than the charm and strange quarks, and so far only the bottom quark has been found. The top quark is postulated because it finishes several complex symmetries seen in elementary particle physics. The problem with finding this quark is its mass. The larger the mass of

photo by Todd Arbetter

An aerial view of the Fermilab complex in Batavia, IL.

The University of Illinois is also involved in the Superconducting Supercollider (SSC) which is a particle accelerator that has been proposed to be built in Texas. This new accelerator will use a ring of magnets 53 miles in circumference to accelerate protons to energies twenty times that available at Fermilab. This higher energy is needed to answer fundamental questions of particle physics which cannot be answered with the existing equipment. Another particle which has been postulated is the Higgs Boson, but its mass is too great for it to be produced at Fermilab, but the SSC might be able to generate it. More power is needed to answer the very fundamental questions of the universe. ■

--- Mark Russell

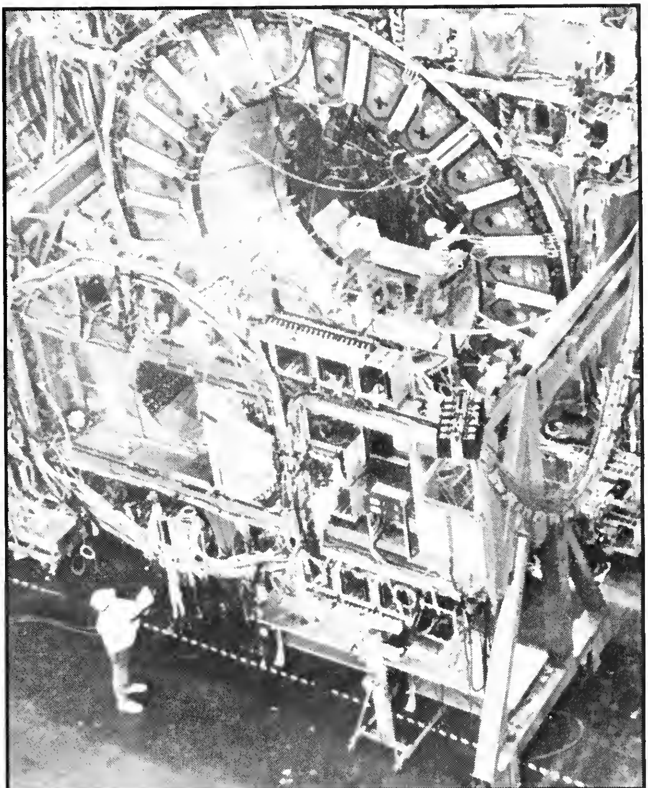

photo by Todd Arbetter

The CDF can detect particles resulting from proton - anti-proton collisions.

the particle to be created, the more mass the original proton needs to have, because only a small fraction of the mass of the proton will go into any one particle. Also for this reason the heavier particles are produced less frequently. The top quark has not yet been found, but the 1988/1989 run of U of I experiments set a lower limit on its mass of about 77 GeV (77 billion electron volts), or 77 times the mass of a proton. This mass is derived from the fundamental equation of Simple Relativity (E = mc2) where the energy of the proton may be related to mass. As the proton is accelerated around the ring at Fermilab, it will increase in mass due to the energy it accumulates. Hence a quark may weigh more than a proton even though they are smaller parts of matter. The researchers will try to find the top quark again in 1991.

Besides looking for the top quark the CDF experiment made precise measurements of the masses of the W and Z particles. They are also looking for data which does not fit the "standard model" of high energy physics.

CDF is also involved in a number of other experiments at Fermilab. One experiment is looking at the production of charm and beauty quarks as photons decay, and another is looking for particles called axions which are low mass neutral particles produced by the decay of -e+e (electron, positron) pairs and photon pairs.

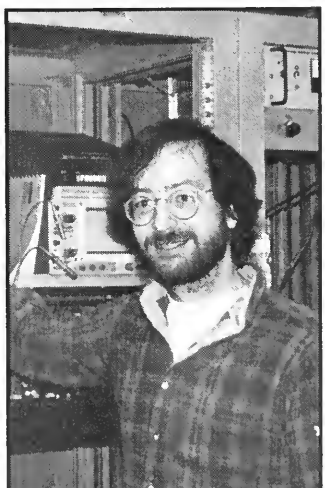

photo by Todd Arbetter

Dr. Stephen Ewede is one of the many U of I professors studying quarks.

Ceramics - Into The '90's

Originally from the ancient Greek word "keramos" for objects fired from clay, ceramics have a longer history than might be apparent at first glance. Structural clay products, whitewares and glass encompassed the extent of the original definition of ceramics. Since then, the definition has expanded to include engineered materials, namely structural and electronic ceramics and glass. Each of these classes of ceramics have unique properties. These unique properties are attributable to the local bonding between the atoms, which in most cases is ionic, or in some exceptions covalent. Other properties include electrical resistivity, high temperature stability and strength. These properties made ceramics uniquely applicable in specialty situations. Electrically, most ceramics (except in superconducting applications) offer exceptional electrical resistivity, making them useful in a number of non-conducting applications. Stability under high temperature applications is also an advantageous result of the ceramic bonding characteristics, enabling them to withstand temperatures two to three times those of metals (ceramics: 2000 to 3000 degrees Celsius, metals: around 1000 degrees Celsius) and four to six times those of polymers (around 500 degrees Celsius). This high temperature stability makes ceramics suitable as refractories into which molten metals may be poured. A final beneficial property if the ceramics strength. Many ceramics can endure higher factors of stress and strain than their traditional metal counterparts, but if they do fail, the results are devastating. This failure is the subject of continuing research at the University of Illinois at Urbana-Champaign.

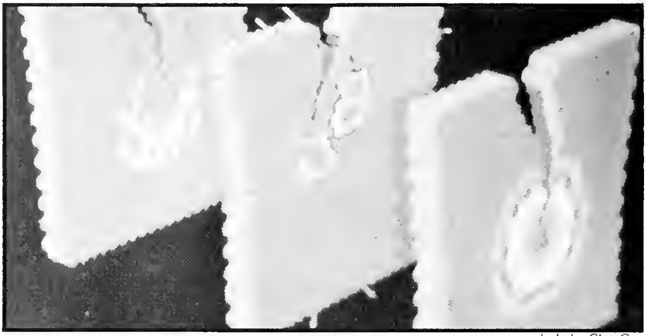

photo by Chris Guy

A stress fracture in a ceramic.

One of the biggest challenges facing engineers today is the tendency of ceramics to fail catastrophically. While many of the ceramics' other properties are on par with, if not superior to, their traditional counterparts, this problem is a major hurdle in the implementation of ceramics in load-bearing structures. Specifically, this failure involves brittle fractures in the ceramic. Having reached a critical size, a crack will propagate exponentially, rupturing the otherwise high-strength atomic bonds. This may be contrasted to a metals superior ductility. Before a catastrophic failure occurs, a metal will endure more stress, often accompanied by its own set of caution sounds.

A process known as transformation toughening now appears to be a possible solution to averting failure. This process involves the introduction of zirconia to retard crack development. A composite ceramic using zirconia has significantly improved mechanical properties. As a crack propagates at a certain critical temperature, zirconia undergoes a volume expansion, pushing in on and effectively sealing the crack. Not alone, zirconia is a member of an ever-increasing number of 'transformation tougheners' that have the common characteristic of undergoing a volume expansion due to certain conditions of pressure and temperature.

It is hoped that this growing body of knowledge will in the future make a significant contribution to the advancement of materials research in general, and to ceramics in particular. With a growing number of materials in the world being replaced by the newer, more sophisticated counterparts, ceramics will certainly be a part of the materials revolution. ■

--- *Alexander G. Guarin*

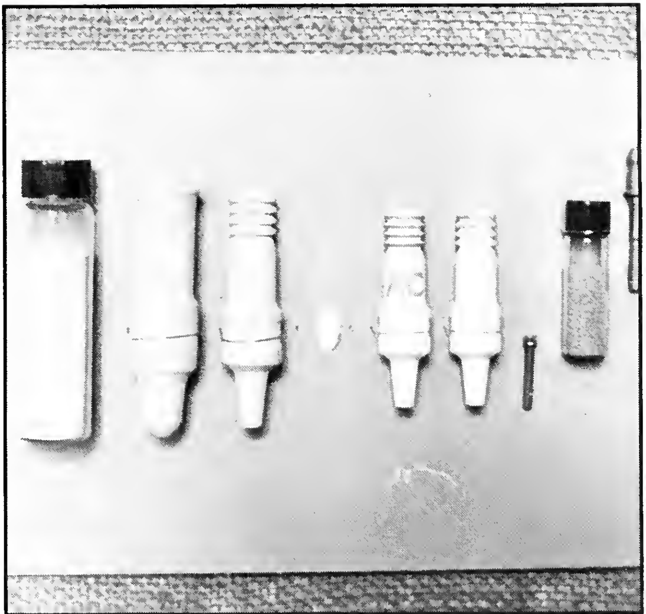

photo by Chris Guy

Ceramics are widely used in modern society.

Techvisions: Can You Identify These Buildings?

photos by Eric Smith

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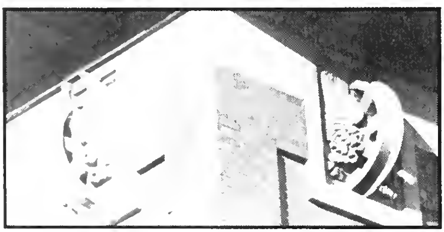

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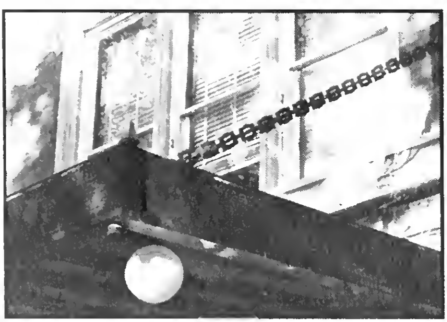

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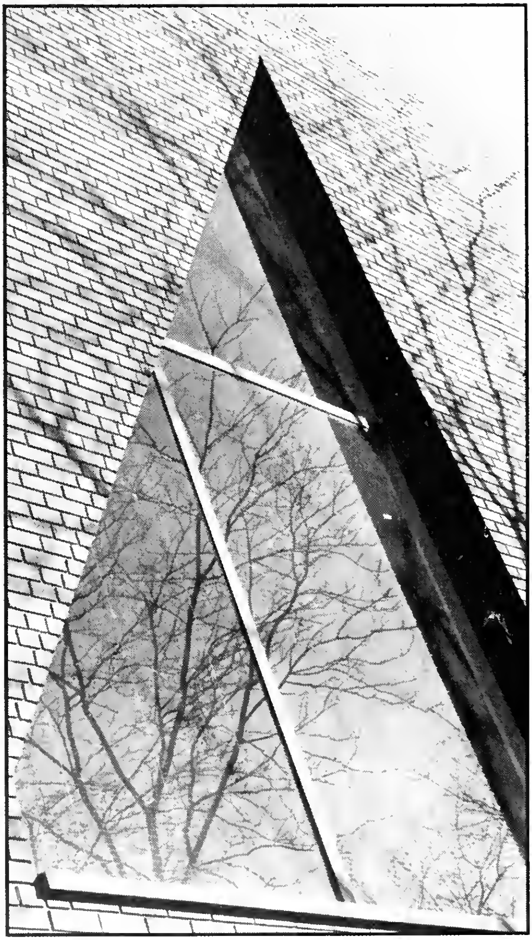

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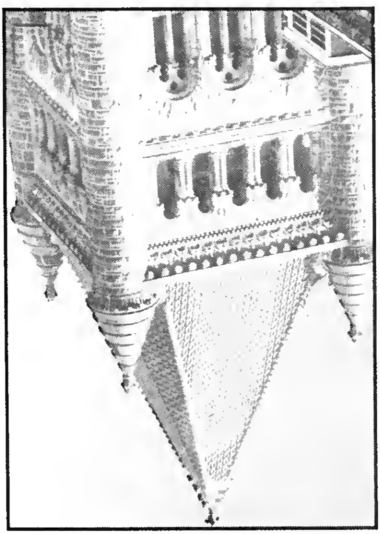

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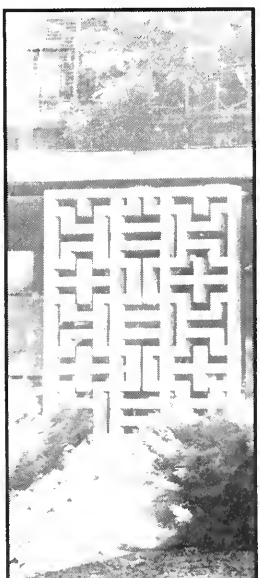

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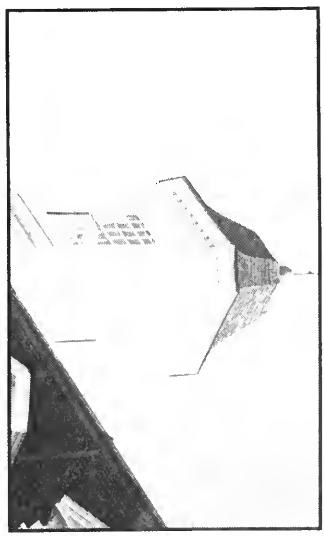

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Bioengineering Clean Water

I enrolled in the University of Illinois' environmental engineering graduate program with a naive goal: I wanted to solve the world's water pollution problems. I had heard about studies linking water pollution to high cancer rates in industrial regions. In Woburn, Massachusetts, for example, several children died of leukemia after barrels of toxic waste leaked into their neighborhood's ground water. I wished to help prevent such tragedies by learning how to detoxify industrial waste.

After a few months in graduate school, I realized that environmental engineers cannot remedy every pollution problem. New hazardous chemicals are being created faster than engineers can discover safe ways to dispose of them; according to one estimate, 1000 new chemicals enter the marketplace each year. The rapid pace of chemical development has forced environmental engineers to undertake research in basic sciences like biology and chemistry to unearth new phenomena that might aid pollution control. I have spent much of my time as a graduate student researching a frontier of modern biology — a discipline I once thought fell far afield of engineering.

A bit of history

To understand how biology relates to water pollution, you need to know some environmental engineering history. In the late nineteenth century, early environmental engineers discovered that when they trickled municipal sewage (what you flush down your toilet) through a deep rock bed, it emerged clean. Later scientists discovered the mechanism that cleaned the sewage water: microscopic organisms attached to the rocks were digesting the pollutants.

> ***New hazardous chemicals are being created faster than engineers can discover safe ways to dispose of them.***

Today, microorganisms are still the primary tools for removing pollutants from both municipal sewage and some industrial discharges. The organisms grow either in filters, similar to the historic rock beds, or in large vats called "activated sludge" tanks. But there is a key difference between modern and historical environmental engineering: Modern pollutants are much harder to degrade than human sewage. Millions of years of evolution created microorganisms that easily degrade human waste. But evolution lags far behind the pace of synthetic chemical development. The natural bacteria upon which environmental engineers have relied for decades have not adapted to digesting all of the man-made chemicals. The most hazardous pollutants travel through sewage treatment plants unchanged, ending up in rivers that may serve as a downstream community's drinking water supply. Consequently, a major challenge environmental engineers face today is developing bacteria that can digest the ever-increasing range of pollutants.

Using genetics to clean water

My research team combines genetics and environmental engineering. In a nutshell, we are studying a way to supply bacteria with genetic material that would enable them to digest new pollutants. The pieces of genetic material are called plasmids. They are the key we hope will unlock the door to a whole new range of solutions to environmental problems.

Plasmids are made of DNA, the substance that encodes the basic life functions of every living being, from microscopic bacteria to humans. Plasmids are not essential for cell life in an ordinary environment; all of the DNA a cell needs to grow and reproduce is stored in the chromosomes. Instead, plasmids contain extra genetic information that allows a cell to survive in a harsh environment.

Plasmids can contain information that allows bacteria to survive in the presence of antibiotics (like penicillin) that would otherwise kill them. In fact, the first scientists to discover plasmids were medical researchers investigating why penicillin was no longer killing certain disease-causing bacteria. More important for environmental engineer-


photo by Todd Arbetter
Bioengineering may be used to clean up many polluted water such as Champaign-Urbana's Boneyard.

ing, plasmids can contain information that allows bacteria to digest extremely toxic substances, converting them to carbon dioxide and harmless cell byproducts. For example, biologists at a California genetic engineering firm discovered a plasmid that permits its host bacteria to degrade trichloroethylene, the most common contaminant at hazardous waste sites.

What is especially unique about plasmids is that one bacterium can transfer a copy of its plasmid to another bacterium of an entirely different species. Microbiologists hypothesize that plasmids move between species when a plasmid-containing cell grows a long filament that attaches to a plasmid-free cell. The filament draws the two cells close together, somehow allowing a copy of the plasmid to transfer. To understand how remarkable the plasmid transfer phenomenon is, consider a large-scale analogy: What if a cow could extend a filament to a human, donating DNA that would enable humans, like cows, to thrive on a pure grass diet?

The capability of DNA transfer between bacterial species is what makes plasmids potentially useful for environmental engineers. Engineers could develop a strain of bacteria with a plasmid that allows it to degrade a target pollutant like trichloroethylene. It is likely that these special bacteria would not grow well in a sewage treatment plant's unique environment (because of temperature and lack of nutrients). But the special bacteria could transfer their plasmids to the cells that are native to the treatment plant, outfitting the plant to remove trichloroethylene from the waste stream.

Speedy plasmids

My research relates to the speed of plasmid transfer. Speed is a key factor in determining whether a particular plasmid could be used for waste treatment. If a plasmid transfers too slowly, plasmid-containing bacteria would wash out of the treatment plant along with the polluted water, rendering a lost effort.

I am trying to verify a simple mathematical equation that sci-

continued from p. 9

entists have proposed to describe plasmid movement. In my experiments, I mix two species of bacteria — one with a plasmid, the other without — and count the number of bacteria that receive plasmids in a given time interval. I have discovered that the proposed simple equation may be inadequate to describe plasmid behavior, because the amount of food energy available to the bacteria affects plasmid transfer.

Many more researchers will need to study plasmids before environmental engineers can use them. In addition to finding accurate equations that describe plasmid transfer speed, scientists must develop new plasmids to handle the ever-increasing number of pollutants. Other scientists can then construct small-scale waste treatment systems to test whether plasmid transfer will work in realistic pollution situations. With so much fundamental research incomplete, we are probably more than a decade away from being able to enlist plasmids in environmental clean-up.

Environmental engineering has not taught me easy solutions to water pollution. Instead, I have learned that solving water pollution problems is infinitely more complex than creating them. We continue to seek ways to clean up the environmental mess we have created. But the true solution to the environmental crisis lies in lowering our chemical dependency — in finding non-toxic alternatives to the hazardous chemicals we now take for granted. ■

--Jacqueline MacDonald

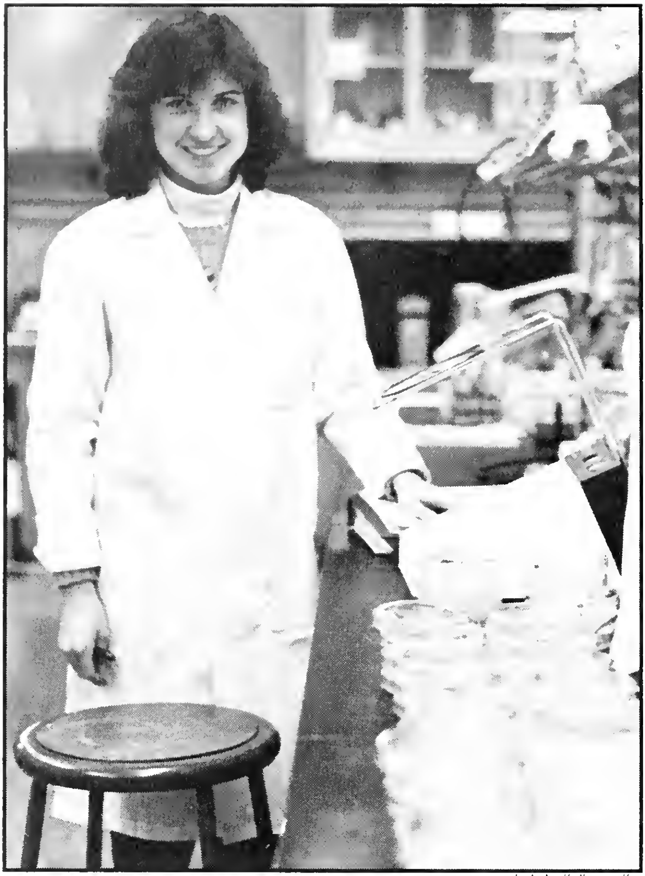

photo by Katherine Kim

Jacqueline MacDonald counting the number of bacteria that recieved plasmids after an experiment to determine the speed of plasmid transfer.

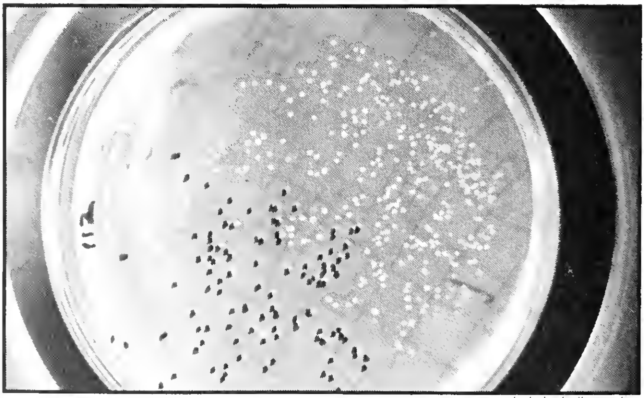

photo by Katherine Kim

A petri dish showing colonies of bacteria that recieved a plasmid to let them grow in the presence of an antibiotic.

Tech-Teasers

1. On the periodic table, Tellurium, Te is element number 52. Iodine, I, is element number 53. Which has the greater gram molecular weight?

2. A boat is made out of a solid piece of silver. Will it float or sink in mercury?

3. Ten boxes are labelled 0 to 9. Digits are placed in each box so that the digit in the first box stands for how many 1's, etc. to 9. What is that number?

4. Instead of ten boxes, 16 boxes are used (the hexadecimal number system). What number is needed to fill the boxes?

-- *Tani Chen*

Term Papers Made Easy...

Imagine using a computerized encyclopedia to look up John F. Kennedy. The computer displays, among other things, a brief synopsis of his assassination. You decide to learn a little bit more about the assassination, so you use the mouse to click on the subheading. Instantly, an in-depth article appears detailing the assassination. Of course, seeing is believing, so you decide you want to see film clips of the assassination. You click on the video icon, and you have instant access to film clips of the assassination and relevant press conferences. If you would like to learn a little bit about th assassin, you could simply click on the name, Lee Harvey Oswald, wherever it may be mentioned in the articles, and you would see his picture as well as a biography and film clips of his assassination. Possibly you are interested in the results of the Warren Report—all that information is available at a single click of the mouse as well. It almost seems that the computer is anticipating the way you think and associate.

This is exactly the goal of a new form of media, hypermedia, which could become the first original and popular form of media since television. The concept behind hypermedia involves sequencing by association. Instead of sequencing information alphabetically, numerically, or in some other obscure fashion that has absolutely nothing to do with the information itself, information is connected to other information which can be associated with it. This means that the sequence in which the user views the information is completely up to the user. The user need not even view all of the information, only that which is relevant to his/her project. Additionally, information is a term which does not apply exclusively to the printed word. Information can come in the form of pictures, graphs, charts, maps, sound, music, and even moving pictures. All of this is available at one computer terminal, instead of having relevant information spread out in different filing cabinets, sections of a library, sections of the country, or even disks on a computer.

The concept of hypermedia can be traced back to a paper introduced in August, 1945, in which Vannevar Bush, director of the U.S. Office of Scientific Research and Development, proposed a machine he called a memex:

> ...in which an individual stores all his books, records, communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility.... With one item in its grasp, it snaps instantly to the next item that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain.

Although his machine was completely imaginary, the concepts Bush proposed were utilized on computers as early as the late 1960's. During 1968, a primitive hypertext system (similar to hypermedia, but without the concentration on graphics and sound) was created to organize NASA documents for the Apollo moon mission. During the same year, Douglas Engelbart introduced the NLS (oN Line System), allowing the Stanford Research Institute scientists to link documents in their mainframe computers.

During recent years, the introduction of the optical disc as a form of mass storage, with its capabilities to easily store the massive amounts of information that represent digitized pictures and sounds, has made true hypermedia much more accessible for practical use. Improvements in software have contributed a great deal as well, for two packages, Apple's HyperCard and OWL International's Guide, are widely available for home computers which alone do not have access to this kind of storage.

The hardware required for future hypermedia systems still looks uncertain. So far, companies seem to have taken two different approaches, and it is far too early to tell which will be more popular at home. some computer companies pair a CD-ROM player with a personal computer in an approach that Apple calls "interactive media." Other companies, such as Sony and Philips, sell interactive CD players with the hopes that they will attract computer-shy people. Although hypermedia seems to be definitely keyed towards the

storage and retrieval of information, this does not mean that its purposes are solely dedicated to reference information, as in the beginning example. In some working examples, of hypermedia, medical schools at Stanford and Cornell are using hypermedia "textbooks" to study human anatomy. The Shakespeare project at Stanford allows students to watch rehearsals and compare scenes from different plays, as well as browse through the wardrobe and prop rooms for each of the plays. The National Geographic Society is presently completing a set of hypermedia field trips that would allow students to travel foreign lands and nations in their own rooms. Ford, Boeing, and Renault are all using hyperware maintenance manuals to diagnose repair problems. Broderbund software is working on a hyperware version of the Whole Earth Catalog. Some authors are even experimenting with the system and writing in nonlinear fashions. Imagine reading a novel-length story tailored to your own interests—be it romance, science fiction, or maybe a western; written from a male's, female's, or third person' s point of view; or dozens of other possibilities.

It would seem though, that the ultimate application for hypermedia would be "the ultimate library," where information on any topic could easily be accessed from any magazine, newspaper, film, record, cassette, or book source ever published. As a matter of fact, Bell Communications, Research is currently working on such a system called Telesophy. A prototype of the system has been running for over two and one-half years. Telesophy contains wire service reports, magazines, journal abstracts, and digitized pictures to which it can refer. About 300,000 such items are currently available. Eventually, it may be possible to use optical fibers to link together comparable libraries at several different locations into a large Telesophy network and retrieve the information over the phone wires.

Hypermedia may also bring another revolution in itself—a revolution of new computer programmers. Hyperware uses "buttons" in order to navigate about associable material. Even the most inexperienced programmer can easily program these buttons on most systems to point wherever and look like any icon they wish. In fact, for a simple, non-interactive hyperware application, all a user needs to do is tell the buttons where to point. There is no written program required to do this much. Although an interactive application does require segments of written code, the code required in most systems is easily learned and very English-like. The simplicity of programming on a hyperware system additionally facilitates a plentiful supply of "public domain" applications, or applications that people may have written for themselves, and the gave away freely. Apple and HyperCard's author, Bill Atkinson, have especially encouraged this, as the HyperCard program is packaged with the Macintosh, allowing for as wide of distribution as possible for the program in the home and business environments.

The ability to program hyperware applications easily does have its drawbacks. Many people not accustomed to programming may be unaware that their applications still need to be debugged just as any other developmental program. In addition, because there is no simple way to view the links between all of the information, there is no way to be sure, outside of trial and error, that all buttons point to the right place, that all information is associated as it should be, and so on. Also, the newer hyperware systems with their more advanced and flashy features pose certain problems. Just as people have overdone fancy fonts and art on current desktop publishing programs, it is certain that they will overdo fancy graphics and sound effects which may only serve to be boring, repetitive, time-consuming, and memory-consuming. Programmers may also attempt to program an application which has no business in a hyperware environment.

The applications of hypersoftware are so numerous that they cannot be adequately represented here. However, these applications are not readily obvious and require some thought as to the abilities of the software being used. If, however, the general computer-using public or the multi-million dollar software companies begin to realize the ramifications that hypersoftware could have on our society, it is certain that hypermedia will become the fourth major form of media along with the printed word, movies/television, and radio. ■

-- John Fultz

Do you know something we don't

If you just happen to know about a neat engineering topic, or you would like to the world to hear about that scintillating research experiment you happen to be performing, **tell us about it!** We pay for articles on just about any engineering topic. Call Chi-Ting at 328-6808 or Minako at 332-4383 for more information.

Pressure Tuned Spectroscopy

photo by Chris Guy

H. G. Drickamer working in the lab on a high pressure experiment.

The application of high pressure in laboratories all over the world enables scientists to make many advancements in such diverse fields as chemistry, physics, biochemistry, and engineering. It's extensive use within the field of science is spurred by the realization that pressure is an effective and fundamental instrument for exploring both molecular and electronic properties of matter.

Percy Williams Bridgeman the forerunner of research in high pressure physics is credited with the invention of apparatus for obtaining very high pressures. His principles are still the basis of modern day improvements in high pressure cell design and devices for measuring over high pressure ranges.

Here at the University of Illinois, Professor H.G. Drickamer and his staff are incorporating high pressure into modern science with the use of "pressure tuned spectroscopy".

The ability to investigate molecular properties and intermolecular interactions in the condensed phase is based on spectroscopically measuring vibrational energy levels of molecules and/or the interaction of molecules with a medium. This spectroscopic data establishes a foundation for defining boundaries between intensity and lifetime in luminescence energy, outlining the principles and the interactions of molecules within the environment, and describing semiconductors and metals.

In condensed phases, pressure, or compression, enhance the overlapping of atoms and molecules. Because of the different spatial characteristics of orbitals, they are disturbed to varying degrees by the increasing overlap. Therefore, it is possible to "pressure tune" electronic and vibrational energy levels. Through pressure tuning, extensive changes can be made in electrical, magnetic, and chemical properties of matter over a range of pressures. These alterations in the properties of matter increase understanding of certain types of properties observed in molecules at a pressure of one atmosphere.

With the use of pressure tuning, Professor Drickamer has performed extensive liquid phase spectroscopic research. Initially, experimentation involved measuring C=O, C-H, N-H, and O-H stretching frequencies for diverse molecules in solvents such as C2Cl2 and CS2. In a paper entitled "Pressure Tuning Spectroscopy", Professor Drickamer concluded that depending on the relationship between bond polarizability and the repulsive force of electrons, a shift to higher or lower energy in vibrational excitations could be achieved. Specifically, a red shift, polarizability, was characteristic at low pressures and a blue shift, repulsion, at high pressure. These results have provided opportunities for new theoretical analyses of molecular interactions in solution.

According to Professor Drickamer, properties of liquids such as volume, viscosity, dielectric constant and refractive index can be altered over large pressure ranges when there are large discrepancies in the liquid properties, (with the exception of refractive index). If molecular properties are measured in the identical medium and over the same pressure range, one can directly establish a relationship between bulk, volume, viscosity, and dielectric constant, and molecular properties.

Peripheral studies illustrate the relationship between inter and intramolecular forces of absorption and emission on bonding and anti-bonding molecular levels. It was found that this difference in energy increased with bond compression. However, since polarizability increases when a molecule has an excited electron, the van der Waals forces stabilize the anti-bonding orbital. According to Professor Drickamer, "For excitations like pi and pi* or gamma - gamma* where the anti-bonding orbital interacts strongly with the environment as pressure is applied, a shift to lower energy is

observed which increases with increasing solvent polarizability." Professor Drickamer notes that there is also an importance in the differences in dipole moment between ground and excited states. A red shift results upon increase of excitation, and a blue shift is observed where the dipole moment decreases upon excitation.

Further studies of high pressure by Professor Drickamer were conducted in the solid state. Pressure induced rearrangements on the molecular level produce many conclusions about solid state chemistry. In the gas phase, or in solution, a molecular rearrangement at a given temperature and pressure relies solely upon the existing free energy between two molecular geometries, (stochastic processes). Since crystal molecules interact strongly, any rearrangement that occurs must occur simultaneously (a cooperative process called a first order phase transition). However, if interactions between molecules are weak, the probability of molecules rearranging is less than one percent, but greater than the probability predicted by the energy difference existing between the two geometries. Professor Drickamer explained the first occurrence in pressure induced rearrangement lying between the stochastic and first order transition as "extent of cooperativity".

Although there is no cooperativity in the gas phase, liquids exhibit intense centralized cooperativity. Crystal cooperativity is basically macroscopic. Polymers, glasses and weakly interacting molecular crystals lie between these two limits.

If intense molecular interactions exist, rearrangement often does not result in the lowest free energy of the "free molecule". This is not a problem as long as the rearrangement results in lowering the free energy of the crystal. In addition, the cause for pressure induced molecular rearrangements in solids is associated with intermolecular forces and packing as well as changes in molecular bond length. Professor Drickamer also notes that since the occupied electronic states of the molecule are altered when rearrangement occurs, changes in electronic spectra caused by pressure "form a diagnostic of the type of change occurring in the pressure range over which this relatively drastic pressure tuning occurs."

In conclusion, the use of pressure tuning of electronic and vibrational energy levels has greatly enhanced our knowledge of molecular properties in liquids and solids as well as many other forms of matter of which were not discussed. Its use in both physics and chemistry exhibit its power and versatility. Future use of pressure tuning spectroscopy may increase our knowledge of delicate molecular properties as well as bring insight for further use of high pressure in scientific experimentation. ■

-- Elizabeth Peszynski

Techprofile: Jean-Pierre Leburton

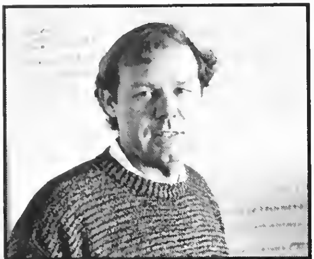
photo by Chris Guy

Outstanding technical people from around the world have chosen to come and pursue their work at the University of Illinois at Champaign-Urbana. One such scientist is Jean-Pierre Leburton, a native of Belgium and an expert in semiconductor electronics.

Dr. Leburton, who is an Associate Professor of Electrical and Computer Engineering here at the U of I, says, " It is the goal of many European scientists to spend some time in U.S. labs." He come here for the first time in 1981 for a one year appointment as a visiting scholar. The appointment was renewed for another year, and following that he accepted a faculty position in the physical electronics group in the Electrical Engineering department.

His chief scientific interest is the physical understanding of semiconductor devices. He and his team of six graduate students, guided by known physical principles and the results of previous laboratory testing, develop models which describe the action of such devices under various conditions. These devices include diodes, transistors, semiconductor lasers, and the like. With each new reduction in size, the physics of making and using these tiny devices becomes more complex. Dr. Leburton and his students use a bank of Apollo workstations in order to crunch out answers that are impossible to obtain analytically.

> ***The cornfields were not too appealing. And also the speed limit; I'm used to driving much faster.***

Although silicon has been the material of choice for the semiconductor industry thus far, new candidates such as gallium arsenide, which is a compound of elements in the third and fifth columns of the periodic table, are the focus of most of his research. "I originally came here because the III-V compounds research group is known around the world as a leader in the field. The latest developments in microelectronics, optoelectronics (traditional circuitry combined with optical elements to speed up performance) and nanostructure devices (electronics with geometries 10 to 100 times smaller than those currently produced) require the use of high purity III-V compounds like gallium arsenide."

Besides doing research, Dr. Leburton is a student advisor, and teaches several courses related to microelectronics, such as E.E. 229 (Introduction to Electromagnetic Fields) and E.E. 340 (Solid State Electronic Devices). Comparing European and American educational systems, he says that, "In Europe it is more humanistic; you get a broader background. In science, the coursework is much broader, and students take more math and fundamental physics courses. In the U.S., training is more practical, more industry-oriented. This is very apparent in graduate study. (U.S.) graduate students work on problems of immediate practical concern."

As an undergraduate student, Dr. Leburton received a Physics degree, and he achieved his Doctorate in Physics from the University of Liege in Liege, Belgium. He worked for Siemens, the West German electronics giant, for two years before coming here. Concerning his arrival in Champaign-Urbana, he says, "The cornfields were not too appealing. And also the speed limit; I'm used to driving much faster. But after one year, you like it here. The people are nicer here than anywhere else I've lived. And another thing- it doesn't rain all the time during the summer, like it does in Belgium. Here, you can have picnics and play tennis without being rained on." Dr. Leburton lives in Champaign with his wife. ■

--- *Geoff Ryder*

A N S W E R S

TECH-TEASERS

1. Surprisingly enough, tellurium is heavier than iodine. Tellurium has a molecular weight of 127.60, but iodine has a molecular weight of 126.90. Other similar "reversals" are argon-potassium and cobalt-nickel.

2. Float. Silver has a density of 10.5 g/cm3 and mercury has a density of 13.5 g/cm3.

3. 6,210,001,000. This is unique.

4. In the hexadecimal number system A is 10, B is 11, C is 12, D is 13, E is 14, and F is 15. The number is C,210,000,000,001,000. This is unique. (Martin Gardner. Mathematical Circus. New York: Vintage Books, 1981.)

TECH-VISIONS

1. Ceramics building backwards

2. Transportation Building

3. Transportation Building (again)

4. Levis Center

5. Krannert (The Foellinger Great Hall)

6. Altgeld upside down

7. Loomis

8. Student Union sideways

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Illinois Technograph

Summer 1990 Volume 105, Issue 4

ENGINEERING

A HEALTHIER

EDITORIAL

The 80's and the 90's have seen an increasing consciousness of the American public about health. Not only health of the body, but also health of the mind (psychiatric evaluations), and academic health (more children are going to college now than in the past). Finally, we are seeing a consciousness of the environment.

With the popular slogan " Think Globally, Act Locally," environmental activist groups are now taking a prominent place in getting Americans to improve the health of their environment.

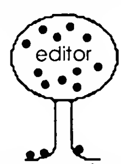
At the University of Illinois, this is especially noticeable in the many waste recycling stations around campus. In the university housing as well, many students have begun a separate waste recycling project of their own. In fact, so much is being recycled, that many of the recycling centers in Urbana are near full capacity.

Recycling is one of the major steps toward smaller landfills and less garbage. Chicago residents will soon be required to separate their garbage and many other cities require lawn or organic wastes to be separated from ordinary household garbage.

Biodegradable materials are also a hot topic in environmentalism. The current "biodegradable plastics" are not really biodegradable in the plastic sense. Most of these plastics are made of cornstarch and regular plastic so that the cornstarch biodegrades but not the plastic itself; it just disintegrates into tiny plastic pieces rather than one big piece of plastic. Other concerns are that biodegradable materials may not necessarily biodegrade if they are not exposed to the proper conditions. One garbage landfill was found to contain dried carrots and old newspapers that had not degraded at all since the landfill did not contain enough moist organic matter.

In order to promote a better environment, many engineers are taking environmental courses. There is even an engineering curriculum called environmental engineering which is administered through civil engineering. A student who wished to get an environmental engineering degree would have to major in civil engineering and get a specialization in environmental. It is not necessary, however, to be a civil engineer first. Many students enrolled in the chemistry curiculum pursue the environmental engineering degree in graduate school.

Americans are becoming more health conscious, and one of the best ways to remain healthy is to keep the environment healthy.



Chi-Ting Huang

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Earth Day Turns Twenty

April 21, 1990 will see one of the largest demonstrations in University of Illinois history. This day will be a part of the celebration of the twentieth anniversary of Earth Day. Much of the planning for the events during the week of April 16 has been done by Students for Environmental Concerns (SECS). SECS has support from over forty student groups and twenty University departments. Activities related to Earth Day have already begun and will continue through April 22.

The first nationally organized Earth Day occurred on April 22, 1970 and promoted ecology and a heightened awareness of the environment. From this first celebration, the EPA was formed and the first clean air and water bills were written. In addition, SECS was founded at the University as a way to maintain an awareness of the environment through both education and action. Since then, SECS has been one of the most effective direct-action groups in the community, initiating and implementing the first recycling program ever at the University, playing an instrumental role in compelling Abbot Power Plant to install scrubbers at their facility, and conducting numerous letter-writing campaigns for environmental issues. Some recent activities of SECS include a recycling drive and tree planting with REM and Star Course, a semi-annual phone book recycling drive, and the student rally for environmental change which drew over 800 people.

During the week of Earth Day (April 16-22), SECS has prepared programs which will combine action, education, and entertainment in the name of heightening the community's awareness of environmental issues. There will be ecology tours to five areas of interest (the recycling center and Allerton Park are two of the five), educational booths, lunch and dinner seminars with faculty and community speakers, and radio and television interviews. Monday through Thursday night there will be speeches by five nationally recognized speakers. Monday night, Nick Lenssen of the World Watch Institute and Ted Flanigan, Energy Program Director of the Rocky Mountain Institute will be speaking on electric efficiency and the greenhouse effect. Tuesday, Russell Mittermeir, president of Conservation International will be speaking on biological diversity in rain forests as part of the ongoing MillerComm90 Biodiversity Lecture Series. Wednesday, Dr. John Browder, Economics Professor of the Virginia Polytechnic Institute and State University will speak on the social dynamics of tropical deforestation. Thursday, Dave Newhouse, Regional Director of the National Audubon Society will speak on wetland protection.

On Saturday, there will be a one woman play, "Planting in the Dust," a recycling drive, a display of the environmental art and design competition entries, and a bicycle repair workshop. There will also be a recycling obstacle course, over 25 education and action booths, refreshments, speakers, and a number of local bands playing "Music for Mother Earth" in an all day concert. On Sunday, the community also has a number of activities planned.

For more information on the activities being planned for Earth Day, look for a calendar of events to be posted after April 7 or so. Also, messages can be left for SECS at the university YMCA at 337-1500. ■

-- Steven M. Frankel

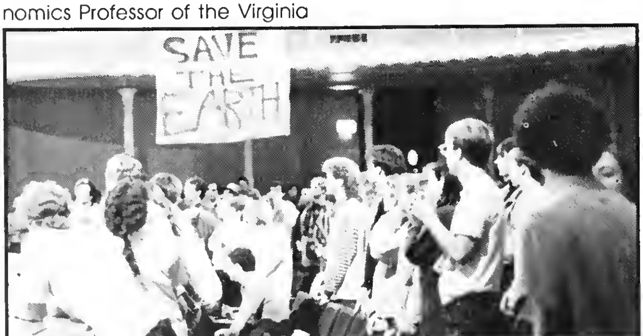


photo by Katherine Kim

Students at the University of Illinois attend an Earth Day rally at Foellinger Auditorium.

APRIL 16 MONDAY

"The Role of Ecologists in Solving Environmental Problems"
Presented by the graduate students of ecology, ethology and evolution
12pm 308 Natural History Building

Earth Day 1990 Kick-Off Ceremony
Sponsored by Students for Environmental Concerns
South quad in front of David Kinley Hall
1pm Tree Planting
1:30pm Chancellor Morton Weir address

Ecology Tour: Rail to Trail Prairie Project
David Monk, Coordinator of Heartland Pathways
(maximum of 30 participants)
2-4pm Meet at the University YMCA

"Electric Efficiency and the Greenhouse Effect: Projections and Responses"
Nick Lenssen, World Watch Institute
Ted Flanigan, Energy Program Director of the Rocky Mountain Institute
8-11pm Illini Union, Rooms A, B & C

APRIL 17 TUESDAY

Focus 580 with guest Russell Mittermier
Russell Mittermier, President of Conservation International
11am-12pm WILL radio (AM 580)

"Looking Ahead into 1990-91" *Know Your University series*
Morton Weir, Chancellor of University of Illinois
12-1pm Latzer Hall, University YMCA

Progressive Community Soup to Benefit Students for Environmental Concerns
11:30am-1:30pm Common Ground Food Co-op, Illinois Disciples Foundation, Springfield and Wright, Champaign

"Conserving Biological Diversity in the Tropical Rainforest: The Challenge of the 90's" *MillerComm90*
Russell Mittermier, President of Conservation International
8-10pm 112 Gregory Hall

APRIL 18 WEDNESDAY

"Solid Waste, Recycling and the Model Community"
John Thompson, Executive Director of the Central States Resource Center
12-1pm South Lounge Illini Union

Ecology Tour: Allerton Park Nature Walk
Gary Kling, Associate Professor of Horticulture, University of Illinois
(Maximum of 30 participants)
1-4pm Meet at north entrance of Illini Union

"A Prospect for Sustainable Agriculture: Energy Farming"
Sustainable Agriculture Spring 1990 Seminar Series
Folke Dovring, Professor Emeritus, Department of Agricultural Economics, University of Illinois
7:30-9pm K-2, University YMCA

"The Social Dynamics of Tropical Deforestation"
Dr. John Browder, Economics Professor, Virginia Polytechnic Institute and State University
8-10pm 228 Natural History Building

APRIL 19 Thursday

Ecology Tour: University of Illinois Composting Center and the Community Recycling Center
Rob Fletcher, Coordinator of the Yardwaste Reclamation site at the UI
Mark Laoughmiller, Director of the Community Recycling Center
Lissa Radke, Education Specialist of the Community Recycling Center
(maximum of 30 participants)
1-4pm Meet at north entrance of Illini Union

"Grassroots Wetland Protection"
Dave Newhouse, Regional Vice President of the National Audubon Society, Great Lakes Region
8-10pm Room 100 Noyes Lab

APRIL 20 FRIDAY

Ecology Tour: The Model Community Walking Tour
John Thompson, Executive Director of the Central States Resource Center
(maximum of 30 participants)
1:30-4pm Meet at Central State Office, McKinley Foundation, 5th and Daniel, Champaign

Earth Day 1990 Student Vigil: A passive protest against environmental destruction and social apathy
Sponsored by Students for Environmental Concerns
4pm Grassy triangle between Davenport Hall and Foreign Language Buildings

Ecology Tour: Earth Connection Gathering.
Tour a prairie restoration project, share a fingerfood potluck dinner around a bonfire and hear storytelling by John White, Ph.D., a native American Indian from the Ancient Lifeways Institute
6-9pm Barnhart Farm, 2 miles south of Urbana
Contact Don Barnhart, 684-2321

APRIL 21 SATURDAY

Earth Day 1990 Nature Expo
9am-5pm Market Place Mall, Champaign

Earth Day 1990 Festival
Sponsored by the Illini Union Board ans Students for Environmental Concerns. Environmental speakers, ecology plays, 30 education and action booths, recycling obstacle course, Music for Mother Earth Concert, refreshments, and the display of Environmental Art & Design competitions.
12-8pm South Patio, Illini Union

APRIL 22 SUNDAY

Earth Day 1990 Nature Expo
11am-5pm Market Place Mall, Champaign

Creation Ceremony: a Nondenominational Worship Service.
Central Illinois Children's Choir, songs and sermons by representatives of four faiths.
12-1pm Boat House, Crystal Lake Park, Urbana
Contact Chris Main, 356-3648

Community Earth Day Festival
Demonstrations, information booths, music, food and family fun
2-5pm Crystal Lake Park, Urbana
Contact Mary Hruska, 398-2768

Earth Day 1990 Benefit Concert
Poster Children and Backwards Day
9-11pm Mabel's, Urbana

Biodegradeable Plastics

Most plastics used today consist of carbon based polymeric chains that are durable, inert and non-biodegradable. While these properties are of great use in applications requiring long-term performance, they are unnecessary and sometimes even detrimental in applications in which the product is to be used for only a short period of time and then discarded. One of the main drawbacks in the latter case is that the discarded plastics retain the characteristic properties of the original product well after being disposed, increasing the volume of non-biodegradable products in landfills and garbage dumps. One of the solutions to this problem that is currently being explored is the development of a biodegradable form of plastic suitable for short-term applications.

Some of the more popular formulations being investigated are those which incorporate a carbohydrate into the structure of the polymer. The main effect sought here is the breakdown of the carbohydrate, leaving holes in the polymer which severely decrease the strength and elasticity of the original product. This weakened plastic is more easily broken down into smaller fragments that are less harmful to the environment.

The presence of the carbohydrate in the plastic also increases the probability that a macro-organism, an insect, for example, will find the composite palatable. In this process, the partially digested polymer is often broken down into smaller components (smaller carbon chains) that are more easily decomposed under the influences of normal environmental conditions. The breakdown of the plastic into smaller fragments also aids the process in that many insects attacking the plastic must do so at an edge.

Another mechanism by which polymer degradation occurs is through the utilization of chemical additives which when activated by sunlight, heat or other catalysts from the environment produce reactions that break down the polymers into smaller carbon chains.

> "*the breakdown of the carbohydrate (in the plastic) ... severely decreases the strength and elasticity of the original product.*"

The most common method currently employed uses sunlight as a source of energy to drive the degradation; many companies employ this technology to produce plastic bags which are degradable. The drawback to this technological implementation is that the bags have to be exposed to the sun to be degraded, but most garbage is destined for landfills and dumps in which they are buried underground and not exposed to the sun. A promising alternative may be the use of catalyzed reactions that serve to break down the polymeric structure. One suggested mechanism involves the addition of oxidative materials that when brought into contact with common soil components produces a chemical that attacks the chemical bonds in the polymer chains, breaking it into smaller, more degradable carbon chains.

Some of the above applications are currently being researched here at the University of Illinois by Dr. Richard Wool, professor of Metallurgical Engineering, who has focused his work on the development of a biodegradable plastic based on polyethylene and cornstarch. The testing has covered such topics as the rate of removal of starch from samples, extent of occlusion of starch granules inside of the polymer, and the changes in the physical characteristics of the samples during degradation.

The rate of starch removal from a polymeric matrix was studied by placing samples of 40% starch composition in various types of soils and observing their degradation. The extent to which the starch within the samples decomposed was determined by the careful measurement of the evolution of carbon dioxide formed in the degradation reaction. It was found that all of the starch was removed from all of the samples within a period of ninety days, with some of the samples in sandy soils losing all of their starch within twenty days.

photo by Katherine Kim

Plastics are widely used in packaging such as in milk containers. Unfortunately, this plastic does not biodegrade rapidly and clutters the environment. One solution is to recycle; another is to find a biodegradable plastic.

The accessibility of the starch granules within the plastic was explored by modeling the polymer/granule system as a linear percolation problem. That is, the system was represented by a sea of polymer dotted randomly with the granules. The threshold at which most of the granules become accessible to microbial attack is at approximately 30% starch (less for thin films). The accessibility of the granules drops off precipitously below this amount, and thus the potential for full degradation drops off accordingly. The predictions of the model were tested by immersing samples of various starch compositions in an acid bath that digested the accessible starch but left the polymer behind. The amount of starch removed was determined by the mass change after digestion. The results of the experiment showed a marked increase in percent starch removed near a starch concentration of 30%, supporting the findings of the computer model. Furthermore, as predicted by the model, the samples of starch content in excess of 30% also exhibited decreases in elasticity and tensile strength of a far greater magnitude than those shown by samples of lower starch content.

These results and others lead the way to the development of a new era in plastics production that will include new composite materials created specifically for short-term use that will biologically or chemically degrade. Benefits from advances like this will be seen mostly be seen a decrease in the volume of necessary landfill to contain our garbage, but they will also include such advantages as the ability of plastic left in the environment to degrade so that it does not remain indefinitely as an eyesore and environmental hazard.

As of now, several institutions and companies are making use of photodegradable plastic bags for customer use or for retail, and several others are working on perfecting fully biodegradable lines of polymers that we may see being used in the next few years. ■

-- *Kristin Ringland*

photo by Katherine Kim

Clockwise from top: starch blend plastic films, oleic acid for chemical degradation, polyethylene, biodegradable polymer blend, corn starch, biodegradable polymer blend.

Surfacing Surface Science

Vaulting across the rolling terrain of interwoven orbitals, they speed their way ever closer to the treacherous, hole-ridden junction. Past obstructions of foreign matter, disruptions of the lattice, and stray bosons, they surge relentlessly toward their goal— drawn ever onward by some unseen force, they plummet helplessly to their demise. With a spray of quasi-particles and photons, they collide, scattering and metamorphosing- fulfilled or failed, they fade sans recognition, sans identity, sans purpose into the background radiation of the cosmos. Such is the life of a conduction electron in a semiconductor.

Semiconductors are applications of solid state and surface science. The surface scientist lives in a unique world. Instead of space and time, he lives in a realm of cycles, periodicity and frequency. Whereas the properties of a gas are derived principally from those of the individual particles, the properties of a solid are fundamentally based on its geometry. A crystal is distinguished by its translational symmetry; that is, in any given direction, the distance between two consecutive lattice points (atoms in an elemental crystal such as diamond) on a line is the same. The geometry may then be described in terms of the number of lattice points per unit length in each direction. This characterization has many practical advantages; this description is equivalent to expressing the Fourier transform of the lattice, so it behaves according to a vast catalog of theorems. Waves traveling through the crystal interact very strongly with the lattice if their direction and periodicity match that of the crystal. When detailed images of a crystal surface are obtained by diffraction, the image is not that of the "real" lattice, but rather that of the Fourier-transformed, or reciprocal lattice. Thus Fourier-space takes on an unprecedented physical reality.

Some Chemical Engineering undergraduate students at the University of Illinois who are interested in surface science applications are currently studying the interaction of light with gallium arsenide crystals. For this purpose, as for most, the crystal structure is not a principle actor, but rather is a non-Euclidean space in which the actors play. When a light enters a crystal, several things may happen. It may be reflected, it may be refracted, it may be absorbed, or it may pass through unscathed. Excepting the last case, the crystal must somehow be affected by these interactions. If an atom in the crystal should be set in motion, the result is a mechanical or vibrational wave that propagates across the lattice, so that the individual motion is lost to a macroscopic view. As Einstein referred to a package of light waves as photons, physicists refer to these mechanical waves (which compose heat and sound) as phonons. Alternatively, the light may impart en-

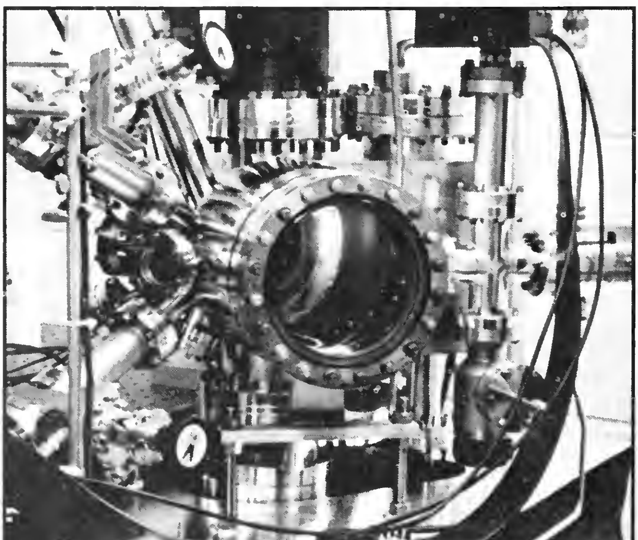
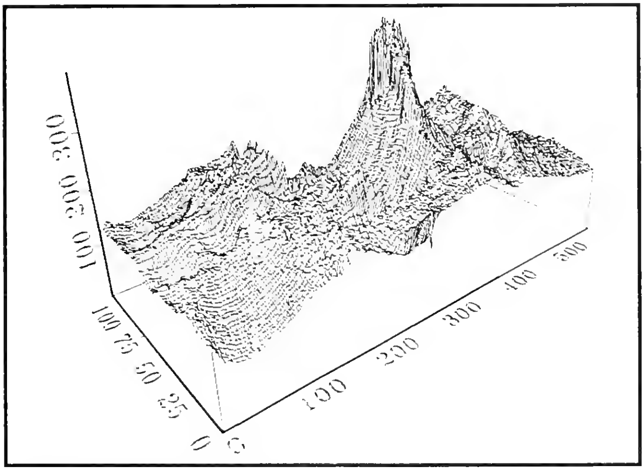


photo by Chris Guy

Vacuum chambers similar to this one are used in the study of surface science.



Surface science studies the microscopic surfaces of semiconducting materials and metals such as copper (pictured here).

ergy to an electron, which, unlike its companion nucleus, possesses sufficient wave-like character, and which may gain sufficient freedom to join with the photons and phonon in their journey across the lattice. Electrons so promoted are called conduction electrons and the minimum amount of energy required to promote one is called the band-gap energy. The band-gap energy plays an important role in determining the optical properties of the material.

The conduction electron leaves behind it a hole, which carries with it all the properties of a state in which an electron could be, but isn't. A positive hole and a negative electron bind together to form something vaguely akin to a hydrogen atom, called an exciton. Two excitons may then bond, as do hydrogen atoms. The functionality of semiconductors is based on the behavior of the quasi-gas trapped within the confines of the crystal lattice. It is the advancement of solid-state physics and surface science that has produced and sustained the present on-going revolution in electronics.

In addition, then, to solutions, gases and differently colored powders, the surface scientist must learn to live with fermions, bosons, excitons, particles of light, particles of heat, gases that aren't really gases, particles that aren't really particles, particles that are really the absence of particles, but which carry charge and having no mass bounce off obstacles, but they aren't anything but a place where an electron could be, but isn't. Pseudo-atoms, excitons, bound pairs; an electron and a "hole" orbit about one another as they trace their way through potential wells, excitons linking together forming pseudo-molecules. An adventure into fourier-space, into the microcosm of surface science and solid state physics is filled with weird and terrible sights and sounds, strange creatures of unrestrained character, heedless of our plain and predictable world.

The surface scientist is concerned not so much with the crystal, nor with what is beyond the crystal, but with what happens when the crystal meets the beyond. Simple symmetries do not apply to this situation. Empty electron orbitals erupt from the surface like the fray of an unfinished garment. The geometry of this array of mathematical abstractions dictate both chemical and electromagnetic (optical) properties of the interface. This presence at the interface exerts its influence to some depth into the crystal, resulting in a boundary layer over which the material properties are not uniform. It is the effect of this boundary layer on photo- and electro-reflectance, or conversely, the characterization of this layer by spectroscopy, that our research team has been studying.

Reflectance spectra is modeled on a computer. The behavior of light at an ideal interface may be described in terms of the dielectric constant using Maxwell's equations. This constant is affected by the presence of an electric field and is consequently a function of the wave-length of the light in question. In addition, the unbonded orbitals at the surface tend to accumulate excess charge, which produces an electric field that diminishes to zero over the depth of the boundary layer. The models are based on a theory that predicts the effect of an electric field on the dielectric constant experienced by a particular wavelength of light. Since a charge in dielectric constant results in reflection, the entire boundary layer contributes to the spectrum. The exact solution to the problem is unknown, but by carefully simplifying approximations and numerical techniques, a variety of models are being developed and tested both here and around the world, as scientists and engineers push forward the frontiers of surface science. ■

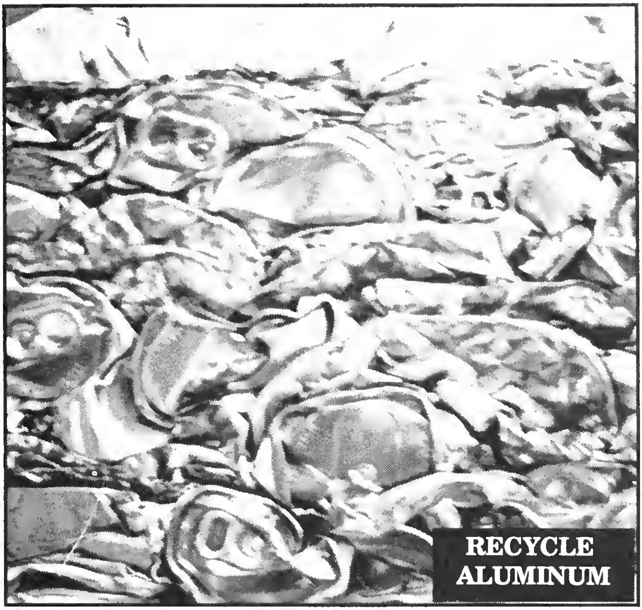
- - Phil Jackson

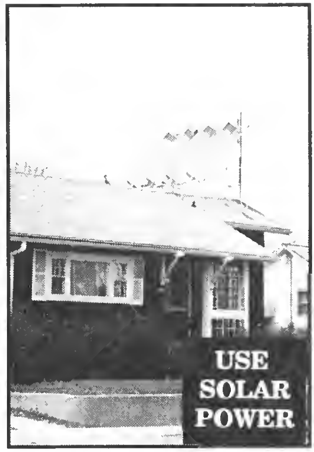
THINK GLOBALLY

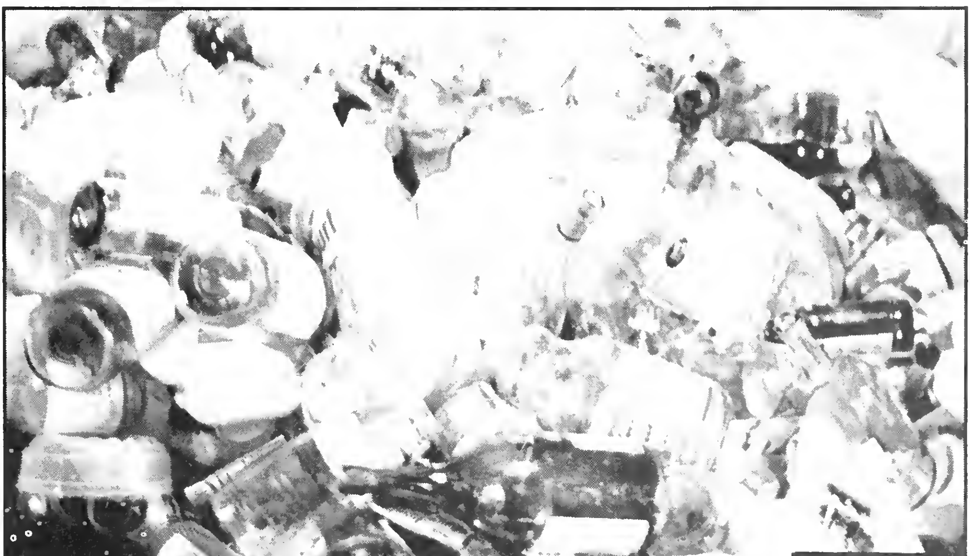
photo from DI Archives

photos by

Katherine Kim







ACT LOCALLY

Educating Engineers

The University of Illinois is well known for its engineering departments, both on the graduate and undergraduate levels. The 1987 Gourman Report, based on a survey of people in academia, placed the University of Illinois in the top ten in all but two of its undergraduate engineering departments. (See table for complete listing of survey results.)

The top rankings don't just happen. A great deal of work goes into planning the curricula and programs through which thousands of students will pass. Within a fairly rigid course structure of up to 132 hours, the College of Engineering must balance the demands for a broader general education background with the need to cover the ever increasing amount of technical material. At the same time, they must deal with the problem of the roles and relative importances of research, graduate and undergraduate programs.

One point of debate centers around the tug of war between more technical requirements and more general education requirements. There is increasingly more emphasis being put on a broader, more well rounded education, with increased exposure to the social sciences and humanities. The university is presently adopting a new set of general education requirements with these sorts of goals in mind. The effect of these new requirements on the engineering schools is not yet clear, but the addition of a foreign language requirement will probably be one of the changes implemented. Certainly the idea of a more diverse background seems to be a good one, but there is another side to all this as well. Technology is continually advancing, resulting in more and more material that needs to be taught. There is increasing pressure from the departments to include more technical material in the programs. Requiring more hours in either the liberal arts or the technical realm extends the program, which would probably meet with some resistance.

There are a variety of programs available to students allowing them to gain work, research and international experience. These programs strive to provide such opportunities by working within the basic curriculum without significantly increasing the course work necessary to graduate. As a general rule, courses are often revised to include recent technological advances so that they are as current as possible, and there are now special options in areas like bioengineering or polymer science.

For students seeking more than an engineering background, there is a combination engineering - LAS program which allows students to obtain degrees in both schools in 5 years. About 100 students take this option, many of them chosing an area such as economics or finance for their LAS degree, so that they are well prepared for management positions.

For those students who want an opportunity to practice what they are learning, there are work-study coops. About 300 students are involved in programs in which they alternate working for a semester and attending classes for a semester, allowing them to learn the necessary technical aspects of their field while gaining practical work skills and earning money. Some students gain practical experience staying on campus by working for a professor and helping with research projects. This gives them an idea of how the things they are learning can be applied and also shows them that there is more to their field than what is taught in classes.

The College of Engineering has realized the important role that international business and relations play in today's technology, and seeks to prepare interested students by offering an international minor in engineering. In this program, students select a specific non-English speaking country or geographic area and concentrate their studies in that area. They are required to complete a minimum of 21 hours of course work, including both study of the language and the culture of their chosen area. They must also spend at least eight weeks living and working or studying in their area. The College of Engineering has study exchange programs with universities in Argentina, Australia (where the emphasis is on Pacific rim countries), Brazil, China, Colombia, the Dominican Republic, France, Germany, Japan, Korea, Portugal and the USSR. The programs vary in length, depending on the universities,

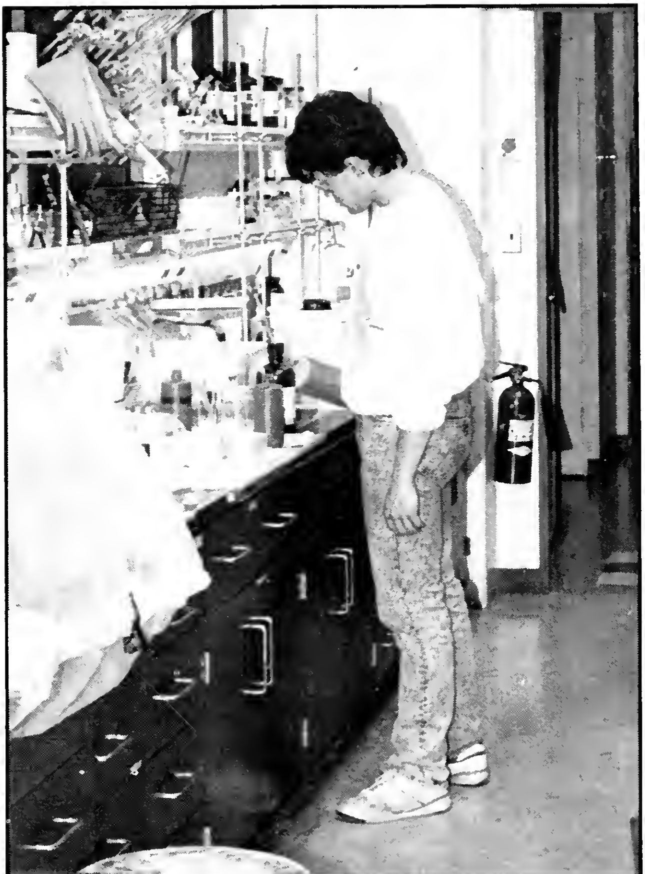


photo by Todd Arbeiter

Undergraduate research is one way students can apply the material they learn in the classroom to real life situations.

and may run just for a summer or last through an entire academic year. Work exchange programs to the same areas are generally organized through the International Association for the Exchange of Students for Technical Experience (IAESTE). To encourage students to take advantage of such programs, the College of Engineering, through the Elmendorf World Citizenship Travel Awards, is able to help some students with travel costs to and from the work or study experience. Students who have participated in such programs find that their international experience makes them more desirable to companies when they interview.

There are of course numerous extra-curricular activities - like the Engineering Open House - which are open to students and which are also excellent ways for them to broaden their perspectives outside of the classroom or special programs. The student who is concerned with a broader background or experiences outside of the classroom will find that the College of Engineering 's special programs provide many

photo by Todd Arbeiter

A typical large lecture hall in the Loomis Laboratory of Physics.

opportunities.

Special programs cannot solve the very real dilemma of the role played by research at a large university. On one side, there is the undergraduate program and the need for well taught classes. On the other is the necessity of research for the large amount of funding and renown that comes with it. There will always be some conflict. Some faculty are strongly interested in research, and undoubtedly come to the University of Illinois for that purpose, and not to teach. All in all though, Dean Wenzel sees the research done by professors and the undergraduate program as mutually beneficial. "We wouldn't be what we are without that (research). Knowledge from the research and graduate programs filters down to the undergrads." Efforts are made to encourage good teaching. The College of Engineering [illegible] both research and [illegible] in its promotion criteria. Various awards are offered for excellence in teaching. Every semester students evaluate their professors, and there is a peer evaluation process as well. Many of the professors enjoy teaching, and certainly the students benefit from professors' research experience. ■

-- *Martha Tanner*

UNDERGRADUATE RANKINGS BY DEPARTMENT

(source: The Gourman Report 1987)

AEROSPACE ENGINEERING

1. MIT
2. Michigan
3. Princeton
4. Minnesota
5. Illinois

AGRICULTURAL ENGINEERING

1. Cornell
2. Texas A&M
3. Iowa State
4. Michigan State
5. Wisconsin
6. Illinois

CERAMIC ENGINEERING

1. SUNY
2. Illinois
3. Ohio State
4. Iowa State
5. Missouri (Rolla)

CHEMICAL ENGINEERING

1. Minnesota
2. Wisconsin
3. California, Berkeley
4. Cal Tech
5. Stanford
8. Illinois

CIVIL ENGINEERING

1. California, Berkeley
2. MIT
3. Illinois
4. Stanford
5. Texas

COMPUTER ENGINEERING

1. MIT
2. California, Berkeley
3. Illinois
4. Michigan
5. Purdue

COMPUTER SCIENCE

1. MIT
2. Carnegie-Mellon
3. Berkeley
4. Cornell
5. Illinois

ELECTRICAL ENGINEERING

1. MIT
2. Stanford
3. California, Berkeley
4. Illinois
5. UCLA

GENERAL ENGINEERING

1. Illinois
2. Maryland
3. Oklahoma
4. Stevens
5. Colorado (Mines)

ENGINEERING MECHANICS

1. Columbia
2. Illinois
3. Wisconsin
4. Georgia
5. Cal Tech

INDUSTRIAL ENGINEERING

1. Stanford
2. Michigan
3. California, Berkeley
4. Purdue
5. Northwestern
15. Illinois

MECHANICAL ENGINEERING

1. MIT
2. Stanford
3. Berkeley
4. Minnesota
5. Princeton
11. Illinois

METALLURGICAL ENGINEERING

1. Illinois
2. Lehigh
3. Ohio State
4. Carnegie-Mellon
5. Penn State

NUCLEAR ENGINEERING

1. MIT
2. Michigan
3. Wisconsin
4. Berkeley
5. Virginia
7. Illinois

PHYSICS

1. Cal Tech
2. Harvard - Radcliff
3. Cornell
4. Princeton
5. MIT
9. IIllinois

LIBRARIES

1. Harvard
2. Yale
3. Illinois
4. Columbia
5. Cornell

Tech-notes

An often heard complaint at large institutions such as the University of Illinois is that the education students receive is very impersonal. The complaint is not a surprising one considering that a professor must lecture to a room of 100 or more students.

The function of an academic advisor is to allow the student some one to one contact with the professor, but a problem similar to that of the large lecture hall also occurs. A professor must, in addition to advising undergraduate students, tend to his own research and graduate students, and he may not have the time to spend on the undergraduates.

Once in a while there is, however, a professor who puts forth an extra effort to help his undergraduate advisees. This professor will receive no extra grant money or accommodation for his efforts; rather, he invests the time because he cares about the students.

On the night of April 3, 1990, the Dean's Student Advisory Committee in conjunction with Arthur Anderson Consulting Company presented the second annual Advisor's Award Banquet to recognize these outstanding advisors.

The award was presented by William R. Schowalter, Dean of the College of Engineering to the following professors:

Joseph G. Bentsman (ME)
Sherman D. Brown (Ceramic)
James V. Canahan (GE)
Leslie Christianson (Civil)
Wayne J. Davis (GE)
Placid M. Ferreira (ME)
J. J. L. Higdon (ChE)
Anastasios Ioannides (Civil)
Chung Laung Liu (CS)
Douglas L. Marriott (ME)
Norman R. Miller (ME)
Ty A. Newell (ME)
David C. Bryant (GE)
John E. Prussing (Aero)
Umberto Ravaioli (CE)
David N. Ruzic (Nuclear)
Mark G. Strauss (GE)
Deborah L. Thurston (GE)
Tsa-Chin Tsao (ME)
John G. WIlliams (Nuclear)
Charles F. Zukoski (ChE)

Tech-teasers

Juan, a drug-runner from Columbia, is trying to transport 50 kilos of cocaine to Miami by boat. On the voyage there Biff, the Coast Guard spots him at a distance, a, and asks him to pull over. Luckily for Juan, a sudden fog rolls in. Unfortunately, he is not too intelligent since he is a graduate of the University of Michigan. He takes off straight in one direction. Biff knows that his boat is twice as fast as Juan's but he does not know in which direction Juan is travelling.

Fortunately for Biff, he is a graduate of the University of Illinois College of Engineering. He is a genius but has fallen upon hard times and has had to take a job as a coast guard to support his wife and ten children. He knows exactly how to catch Juan before he can deliver the cocaine and ruin countless young lives.

In what direction must Biff go to catch Juan?

answer on page 16

Tech-Profile: Phillip Geil

Professor Phillip Geil, Professor of Polymer Sciences in the Materials Sciences and Engineering Dept. at the University of Illinois, began his years in college as many college students do—without a clear idea of his future. Starting out in chemistry, Professor Geil worked his way through Wisconsin State College to attain his B.S. At the University of Wisconsin at Madison, he earned his Ph.D. in biophysics in 1957. As he looked for the job prospects, he was still unsure of his future. He decided to go to DuPont when he was offered a chance to join a fledgling polymer physics group which was investigating crystal structure similar to the organic molecular structure he had investigated in viruses. This was a more exciting portion of Geil's career, for he was allowed to do scientific research without being overly hindered to do something practical or to publish while he was there.

After 5 years at DuPont, Professor Geil followed up his first industrial experience with work at the Camille Dreyfuss Laboratory and Case Western Reserve University. He decided to move to the University of Illinois from Case because the U of I had a research grant about twice as large, and there were many more opportunities abound on the U of I campus.

In the ten years that Professor Geil has spent at the University of Illinois, he has stressed that polymer sciences should become an important part of the University curriculum. Geil currently plays a leading role in the push for an offering of a polymer science concentration. The University currently has no undergraduate program in polymers, but future existence of the concentration does look hopeful. He has even tried pushing for increased awareness of the importance of polymers outside of the university by convincing chemistry teachers at the high school and college level to include polymers in their chemistry programs. He insists that polymers are the wave of the future, especially in construction. Geil believes that steel will eventually be phased out as a construction material as polymers take its place. Even now, polymer additives are replacing steel in reenforced concrete.

> ***Geil believes that steel will eventually be phased out as a construction material as polymers takes its place.***

Professor Geil will continue to attempt to prod the University into what he sees as a new age of polymers. He does foresee a steady growth in the University program, but he believes that a science like polymers may outgrow anybody's attempts to catch up with it unless education in polymers everywhere improves. ■

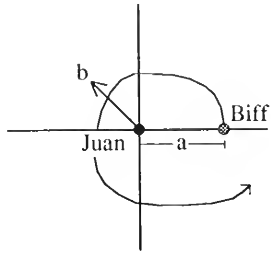
- - John Fultz

Correction EOH Guide 1990:

The EOH Central committee would like to thank Akila Srinivasan College Exhibit Chairperson for her time and help on EOH.

Tech-teasers answer

The answer is that Biff must travel in a spiral until he intersects with Juan. The spiral is given by the equations below:



$$v = \frac{dr}{dt}r + r^2\frac{d\theta}{dt}\theta$$

$$|v|^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2$$

For Juan:

$$|v_J| = b = \frac{dr}{dt}$$

$$|v_J|^2 = b^2 = \left(\frac{dr}{dt}\right)^2 \qquad \text{no } \theta \text{ dependance}$$

$$r = bt + c \qquad \text{since } t = a/b \text{ at } r = a$$

For Biff, the solution for $t \geq a/b$:

$$|v_B| = 2b$$

$$|v_B|^2 = 4b^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2$$

$$\text{for } t \geq a/b,\ \frac{dr}{dt} = \text{speed in r direction must match Juan's}$$

$$\left(\frac{dr}{dt}\right)_B = \left(\frac{dr}{dt}\right)_J$$

$$(r)_B = (r)_J$$

$$4b^2 = b^2 + b^2t^2\left(\frac{d\theta}{dt}\right)^2$$

$$t\left(\frac{d\theta}{dt}\right) = \sqrt{3}$$

$$\theta = \sqrt{3}\ln(t) + c \qquad \text{since } \theta = 0 \text{ at } t = a/b$$

$$\theta = \sqrt{3}\ln\left(\frac{bt}{a}\right)$$

$$\theta = \sqrt{3}\ln\left(\frac{r}{a}\right)$$

$\therefore$ Biff must travel in a direction given by:

$$r = a\,e^{\theta/\sqrt{3}},\quad \theta = \sqrt{3}\ln\left(\frac{r}{a}\right) \qquad \text{for } t \geq a/b$$

$$r = a,\quad \theta = 0 \qquad \text{for } 0 \leq t \leq a/b$$

to catch Juan.

We're sorry...

Since this is the last issue of the year, it is too late to join the Technograph staff.
However, it is not too early to join the 1990-91 Technograph staff!

Positions are always open for writers and photographers. Additionally, positions are open in business with opportunity for rapid advancement. We are also looking for an EOH editor to serve as a liaison to the Engineering Council.

ILLINOIS TECHNOGRAPH

Vol 106
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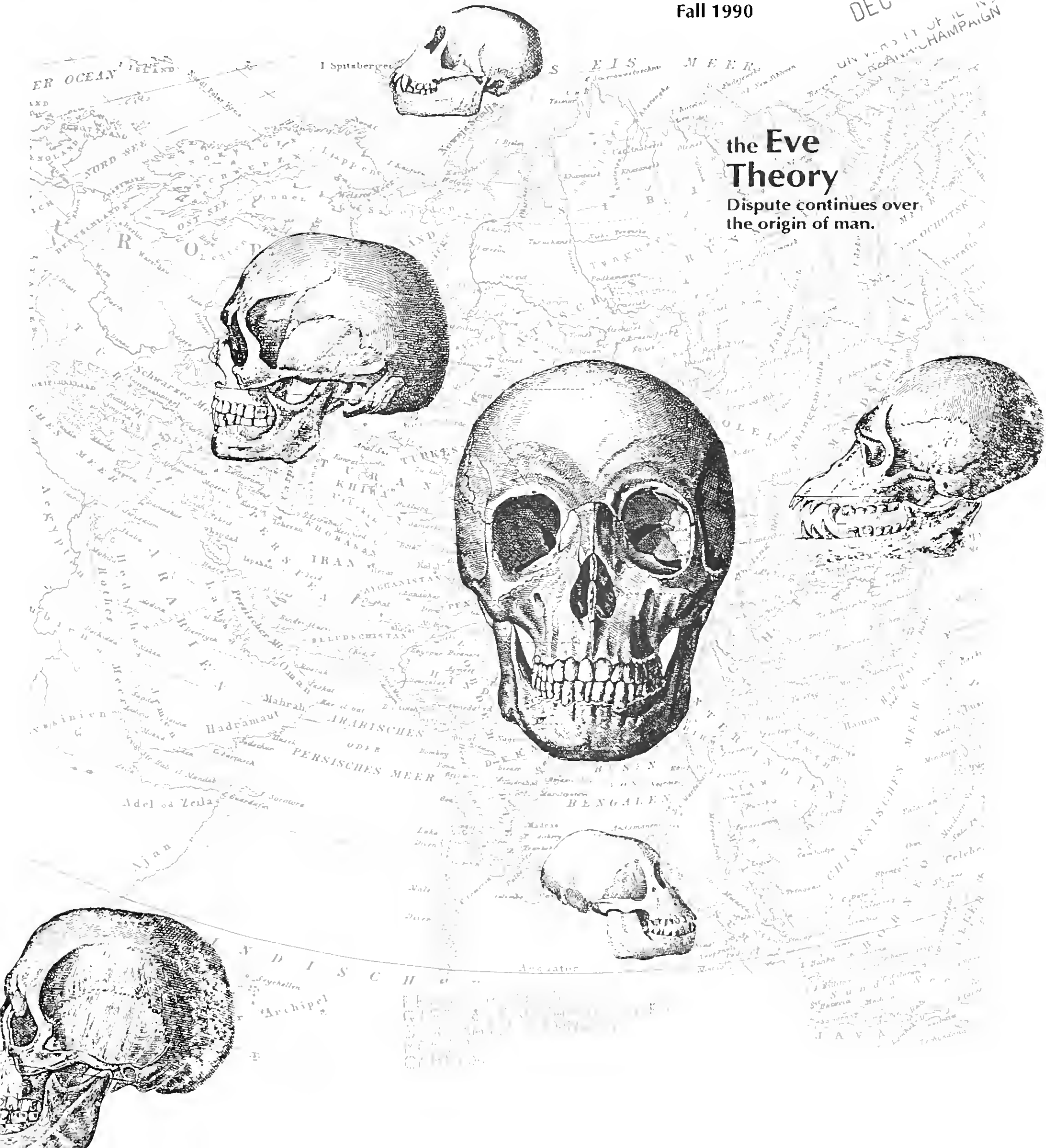
Fall 1990



the Eve Theory

Dispute continues over the origin of man.

At Amoco, what's good for people is good for business. Consider, for example, our Pipeline Safety and Integrity Initiative — a $250 million improvement project. Doug [illegible], civil engineer, was less than a month out of college when he joined a Pipeline Initiative project team. His challenge: design and implement plans to upgrade 53 miles of outdated oil pipeline. Through Doug's efforts, we replaced the old, multi-pipe system with a 35-mile consolidated pipe. It's a breakthrough in efficiency and economy. But more importantly, the new line is so safe it can run beneath public places, like this park in Houston, Texas, where children play. When Doug helped create a pipeline people can live with, he also gave a jump-start to his career. This was just the first of many opportunities he'll have to make a meaningful contribution to important projects. If you've got what it takes to make the world a better place, you've got a career at Amoco.

Amoco Corporation
Choose the big business that makes a big difference.

AMOCO

ILLINOIS
TECHNOGRAPH

this magazine is printed on recycled paper

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editor's remarks

John Fultz

Most people who love engineering have an unusual ability to focus themselves in their work. This ability for focus, especially under the strains, demands, and deadlines required for engineers, makes us somewhat of an unusual breed. After all, there are few more demanding tasks than a four year (or more!) program at an engineering school that rates as the University does. I think, however, that some of us have a tendency to lose our focus on some of the other important issues which have indirect, but broad-reaching implications in engineering and life in general.

The Technograph has often published articles in the past which have attempted to transcend engineering. Some have delved into the realms of pure science upon which engineering depends, and others have regarded how society deals with engineering and how engineering deals with society. From engineering law to the environment, we have struggled to illustrate the engineer's impact on the world.

This issue, for example, we have included "The Eve Theory," a piece that details our quest to know the origins of mankind, and an article on this year's Engineering Employment Expo, which summarizes one way an engineer might have to deal with today's society in order to receive wages for his hard-earned knowledge. These pieces hopefully provide a blend of the liberal science issues and engineering related issues without straying from the original purpose of the magazine or boring the readers.

More of us should also strive for another focus, whether it be in art, science, math, or literature. We, as an engineering body, should take steps such as volunteering our services to the people who need them and taking elective courses we like instead of blowoff courses. We also need to become more involved; we need to represent ourselves in places where we are often poorly represented such as in politics and the mass media. We need to let people know that we are not the nerds they think we are, but we are people who truly want to help other people, whether by building a bridge to make life more convenient or by building an artificial heart to make life possible.

If you have a dream you have not conquered, such as tackling the works of Shakespeare or becoming a youth counselor, perhaps you should try. After all, engineering is only one aspect of your life.

John R. Fultz

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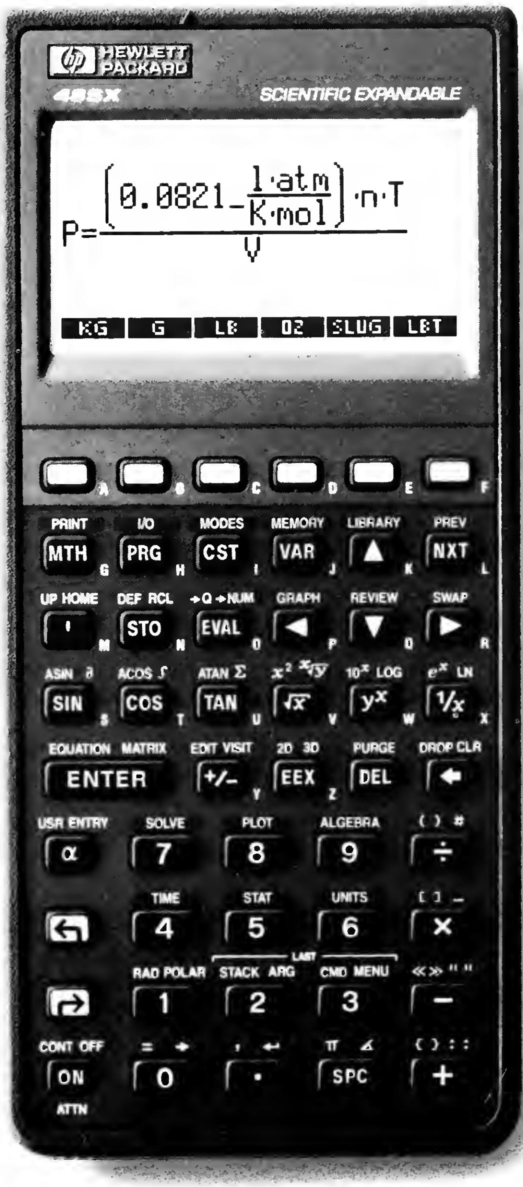

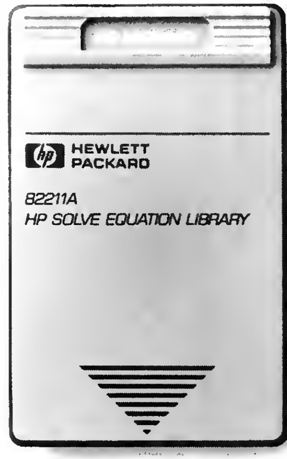

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EXPO 90

Mark Maslov

Engineering Employment Expo '90

Most engineering students will at some time face the ominous task of looking for a job. But where does someone who has been a student all his life begin? Where would he like to work? Who will hire him? The answers to these questions could be found at Engineering Employment Expo '90. This job fair was held September 10 and 11 in the Illini Rooms at the Illini Union. Representatives from over one hundred companies participated in the event that assisted both students and com-panies in the job placement pro-cess.

Getting information at the Expo was no problem. Many companies were there to be seen, and so the representatives were aggressive. Just standing and surveying the surrounding 75 booths, a visitor was likely to be approached by a representative from Kimberly Clark offering a packet of Kleenex and some pamphlets. Although most representatives did not approach you like this, they were all more than eager to help and answer questions.

At least as memorable as the representatives were the displays. Many companies showed videotapes or demonstrations of their products. Because it was noisy in the Illini Rooms, it was nearly impossible to hear the videos. Hence the most effective demos were the most eye-catching, such as IBM's crowd-pleasing demonstration of its VGA graphics.

Other companies filled huge, lit-up display stands with their products. This was especially true for companies producing consumer goods because the packaging of these items is meant to grab your attention. And if that wasn't enough to draw you to the booths, several companies gave out little goodies like those foam "mug warmers."

So many different kinds of companies participated, there was something for every engineering discipline. Most students probably were not very familiar with a lot of the companies. No matter what their field, students at the Expo could see where they might be interested in working or which companies might be interested in hiring them.

While in town, a few companies put on additional seminars for those who wanted to get to know a company better than they could just from being at the Employment Expo. The seminars didn't have the chaotic mobs of people that were at the Expo, so the representatives could discuss things in a little more detail.

Of course, when it comes to hiring, different companies do it different ways. While some companies accepted resumés at the Expo, most companies were not there solely for that purpose. Instead, they are sending representatives to the University of Illinois around October to conduct interviews. And for students interested in summer internships, most companies that have summer internship programs indicated that the job fair in the spring would be a better time to look into that. As a rule, informative pamphlets were more plentiful at the Expo than job applications. Still, whether you were looking for a job or just seeing what was there, you couldn't lose by going to Engineering Employment Expo '90.

A NEW CHOICE FOR ENGINEERS

Jennifer David

"So, what's your major?" Countless times in a given semester students throughout the University are asked this question. Due to a recently developed department in the College of Engineering, however, you might be surprised to find that some of your fellow students are coming up with a new answer to this routine query. The recently created Materials Science and Engineering Department at the University of Illinois reflects the dedication of the University to becoming a world leader in the area of high technology materials and composites.

When the head of this new department, Professor James Economy, joined the Engineering faculty in the Spring of 1989, he outlined several objectives in creating a top undergraduate Material Science program. The first and one of the most challenging of these goals was designing a totally new curriculum to effectively prepare students to excel in industry.

The department consists of four separate but equal divisions: Ceramics, Metals, Polymers and Electronic Materials. Only two of these four, Ceramics and Metals, were originally departments in their own right. Selected Polymer and Electronic Materials classes were available to students in both of these areas. The development of one department encompassing all of these fields was undertaken with the premise that, in today's world, knowledge of just one material is not enough. In Professor Economy's opinion, "People who graduate with a straight Ceramics or Metals degree face technical obsolescence because they are only equipped to work in one area."

Industry today needs people who can use what they know about all kinds of materials to create something new. While there is still a need for a metallurgist or a ceramist, in the future there will also be a need for people to work comfortably between these two fields.

The challenge, then, is to create a degree in which the student can gain a broad working knowledge of materials while still being able to specialize. Dr. Economy feels that the Materials Science curriculum being developed accomplishes that goal extraordinarily well.

For the first two years, a student in the program must take the general courses required of all engineering students, plus one class in structure property relationships. The junior year gives the student the background needed to work with a wide range of materials. Classes in synthesis, processing, characterization, kinetics and thermodynamics are taken in each of the four divisions. The fourth year student chooses an area of specialization. Specializations are in Ceramics, Metals, Polymers, Electronic Materials, or some combination of these. Upper level classes include more sophisticated processing and in-depth understanding as well as design, synthesis and characterization.

The Department is currently what Dr. Economy calls "middle-sized" in terms of faculty and student enrollment. It is expected to grow as industry increases its demand for high technology materials.

The department encourages its students to visit their high schools and share their experiences with the Materials Science curriculum, and also holds informational summer sessions for high school teachers.

Some of the topics being investigated by faculty and graduate students include bioengineering of artificial bone, martensitic transformations in ion alloys, evaluating properties of corn starch-based biodegradable plastics, development of superconducting materials, and development of strong, lightweight ceramics from inexpensive raw materials for building construction. In general, the undergraduate course requirements are so structured that students do not get the opportunity to work with a research team for more than a semester or so.

Professor Geil is the current head of the Polymer department. When changes in curricula were first being discussed, he was asked if he would prefer to see a Polymer department or a new department with equal divisions of Polymers, Metals, Ceramics and Electronic Materials. He felt and still feels that the best idea was the creation of the Materials Science department. He believes that in the future, universities who want to be technologically current will develop Materials Science programs structured similarly to ours.

As the demand for technologically advanced materials increases, so too does the need for innovative, knowledgeable engineers to improve these materials and applications of them. The Materials Science Department at the University of Illinois offers a challenging curriculum that will set the standard of education of young engineers in this growing field.

For further information, about the Department of Materials Science and Engineering, contact the coordinator for the department: Professor Jim Nelson, 312 Ceramics Building, 333.0235

THE EVE THEORY

Joanne Shineflug

The question of where and when modern man arose has beguiled scientists over the centuries, but the issue has taken on new scope and a more violent tone in light of a recent study.

On January 1, 1987, three biochemists announced that modern humans are descended from one woman. Moreover, they traced this woman to the time and place where she arose and repopulated the world with her offspring. In doing so, they tipped off an unprecedented controversy in paleoanthropology over whether the origin of modern humans lies in the in the earth or in a test tube.

Eve, as she is called, presents a marketable answer to the long standing question of human origin — that her offspring completely replaced other early human populations. However, the paleoanthropologists, whose careers are put in jeopardy by the Eve hypothesis and who were virtually silenced by the press coverage it received, are succeeding in making their opposition heard.

One such paleoanthropologist fighting on the front lines is University professor Geoffery Pope. Pope and his colleagues believe that modern *Homo sapiens* do not have a single origin. They think that there was much inbreeding, or gene flow between populations, and that fossils show regional continuity through the ages between *Homo erectus*, our earliest common ancestor and humans today.

Pope has spent ten years working in East Asia, and says the evidence he's uncovered there does not support the Eve hypothesis.

"We want to see the other side of this thing told," said Pope, *"and I don't think that's been done yet."*

The 1987 study was done by Rebecca Cann and Mark Stoneking under the direction of Allan Wilson at Berkeley. Based on a study of proteins done in the 1960's which determined when humans diverged from apes, the biochemists set out to prove that the date when the modern human line broke from our extinct ancestors is locked in the mutations of mitochondrial DNA (mtDNA).

Mitochondria, which are cellular organelles, work like power plants, converting chemicals into energy to fuel the cells. Inside the mitochondria is the type of DNA which the study says can be traced right back to Eve. Because mtDNA is inherited only from one's mother, differences between the mtDNA from mother to daughter must result from random mutations. The biochemists say because the mutations occur at a predictable rate, they can measure these mutations, determine how long it took for them to add up, and develop a "molecular clock" by which to date the divergence. The more mutations, the further back in time was the separation from the main population.

By taking mtDNA samples from the placentas of women from Europe, Africa, Asia, Australia and New Guinea, the Wilson team looked at the differences in mutations in each population, and found that the African population had the greatest diversity of mutations, making it the oldest. According to the molecular clock, our last common ancestor, Eve, lived just 200,000 years ago, not 1 million years ago as the anthropologists hold.

If what the biochemists say is true, paleoanthropologists are out of business. *"It's saying that everyone who studies archeology outside the lab is irrelevant,"* said Pope.

The Eve hypothesis assumes that all decendents of *H. erectus* were replaced between 100,000 and 200,000 years ago by invading Africans with no interbreeding between the groups. In order for two groups of the same species to exist side by side with no mixing, the takeover had to be instantenous and probably violent.

"Neither archeology or bones show any evidence of this," said Pope. *"In this case, two strikes and you're out."*

According to Pope, the invasion should be documented in the archeological record by an advance in tool types, or a "Rambo-type technology", as he has coined it, which must have put the invading Africans at such an advantage that they wiped out everyone else. *"This would be a cataclysmic event,"* said Pope, *"One is suspicious of its validity when there is no evidence of a period of co-existance."*

Although superior tool technology has been seen in Europe, it has been associated with both the Neanderthals and the moderns. But there is no evidence of a new tool technology in parts of East Asia according to Pope. The tools they used 10,000 years ago are the same as ones used a million years ago.

Some Eve supporters argue that the tool technology found in East Asia is evidence of backwardness, but Pope says that stone tools were not as important for their survival in the East Asian forest environment as they would have been in populations which lived on savannahs or grasslands. The most prominent natural resource in the part of East Asia where the unformed tools are found is bamboo, which Pope says could be made into anything necessary for survival. It could even be eaten.

Pope claims Asia is an important geographical area to prove or disprove Eve because it is one of the most isolated areas, and anything new coming in should leave a record. Pope's latest evidence disputing Eve is found at Xiaochangliang, a site which is filled with "nicely made artifacts" at a level of sophistication equal to that of Upper Paleolithic tool kits. The site is located 180 km northeast of Beijing just outside the boundary where the bamboo starts, making stone tools important for their survival. But the catch is the site is dated at about one million years old, which refutes the notion that *H. erectus* was little more than an animal, lacking cultural capacity.

"The idea that there was a Pleistocene holocaust with invading Africans replacing everyone is wrong," said Milford Walpoff, a paleoanthro-pologist at the University of Michigan in Ann

Arbor. Walpoff has studied fossils from all over the world and, like Pope, claim that they show regional continuity.

According to Pope, who specializes in facial features of skulls, the bones show regional continuity from *H. erectus* to modern humans. That is, there are characteristics found in the East Asian *H. erectus* population which can be traced into the modern population. Pope claims there are no abrupt changes in morphology, archeology or neurobiology through the evolution. The finds at Xiaochangliang show East Asian *H. erectus* was capable of making sophisticated stone tools. In addition, endocasts of brains show that the *H. erectus* had reorganized itself like the modern brain.

According to Pope, certain morphologies have highest frequency and appear earliest in East Asia. One important trait unique to the area which Pope is studying is a notch in the face of the skull called *incisura malaris*. This notch appeared in *H. erectus* 200,000 to 400,000 years ago and is unknown in the genus Homo outside of Africa until the coming of modern humans. *"The most parsimonius explanation is that it originated and spread from there,"* said Pope.

Other traits Pope has found in East Asian populations include a short maxilla, smaller jaws, a reduced face and shovel-shaped incisors. Some of these traits are found in African and European populations, which means that there had to be gene flow between the populations. The key is that the traits are found in higher frequency in the Asian populations. *"I'm not going to say humans come out of Asia,"* said Pope. He explained that modern humans are a hybrid. *"You still get regional characteristics. We're talking about the frequency."* The appearance of these traits also refutes the Eve hypothesis because it maintains that all modern genes came solely out of Africa.

Pope said the earliest modern human was found in East Asia, and was dated at 280 thousand years ago. The next earliest date comes out of Kafez, Israel at 100 thousand years ago, but these dates are unsure because there is no agreed upon method of dating this period. Pope believes the date from East Asia is a little early, but it is still much earlier than the date claimed in Israel.

Equally menacing to the Eve hypothesis as the story the bones tell is the paleoanthropologists' argument that there are many problems with using mtDNA to date the origin of modern humans. The biggest problem in Walpoff's view is the whole idea of an mtDNA clock. According to Walpoff, the biochemists have no basis for it. *"We have little pieces of a clock,"* said Walpoff. In order for the clock to work, the mutations have to be "neutral," which means they can not be subject to the pressures of natural selection. In other words, the biochemists assume that no mtDNA genes have dropped out during the course of evolution. Walpoff thinks the biochemists are seeing the left-overs which show that there are other influences affecting the clock. He said that mtDNA is a useful approach, but is not applicable to dating the origin of modern man.

Another problem concerns the nature of the mtDNA itself. Because it is passed on from mother to daughter, it is stopped by a generation of sons the same way a surname dies out if it hits a generation of daughters, and can happen in as soon as 10,000 years, explained Pope. This means the mtDNA from Eve may have constituted a whole population because other strains died out, but this is not the same as saying that we all descended from one female.

Another problem concerns the dating of Eve. In order to date Eve, the biochemists used data from Australia and New Guinea, which were settled between 30,000 and 40,000 years ago. Using this information, they calculated the rate of mutations over millions of years. Furthermore, Australia and New Guinea are situated on the same continental shelf and could have been crossed by early humans durning the Ice Age. The biochemists assume that when Australia was settled, no communication took place, but the populations of Australia and New Guinea look similar. *"We know Australia was populated from watercraft,"* said Pope, adding that it is unlikely that people forgot how to sail.

The controversy between those who support Eve, and those who support regional continuity has become bitter. Pope says the division between Eve believers and those who embrace regional continuity falls along European-American lines, with the Europeans supporting Eve. Part of it has to do with the stigma of being an unintelligent thug that the Neanderthal species has carried.

"Yet Neanderthal produced beautiful tools — all those things we associate with modern humans," said Pope. He thinks that some people are unwilling to believe that Neanderthal genes may be in the current European population. *"That's the only explanation I can think of why it's so heavily supported in Europe."*

What strikes the nerve of a paleoanthropologist, according to Pope, is the argument of the Eve supporters that they are "hard" scientists, and so their theory is right. Pope claims that many of the Eve supporters have not looked at the evidence from China which supports his theory of regional continuity, because it is complicated and often requires an understanding of the Chinese language along with the ability to read the bones.

One reason that Eve finds popular acceptance is that she is the easy answer which tends to make good press. The kind of evidence the palaeoanthropologists are uncovering does not make front page headlines, and doesn't have the sensational appeal of Eve. *"It's dramatic, it's easy to understand,"* said Walpoff. *"Our ideas are more complex [than the idea] that there are killer Africans which wiped everyone out."*

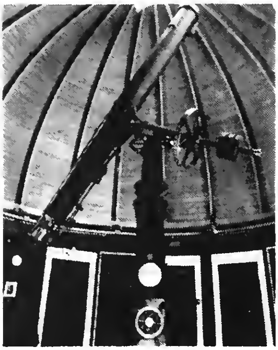
Walpoff also pointed out there are relatively few paleoanthropologists who accept Eve; many either do not embrace the hypothesis or have not stated exactly where they stand on the issue. Therefore, the few who do support Eve have a disproportionate say in the press in contrast to the majority.

Another reason the issue is so controversial according to Pope is *"people are emotionally involved in the origin of themselves. . . there's nobody who doesn't care about where they came from."*

What researchers are finding out, though, is that archeology, biology, and the environment all have to be considered in any thesis concerning the origin of modern humans. As Pope has maintained, *"One good thing that's coming out of Eve is that people realize that you can't separate these things anymore."*

TECH VISIONS

The Observatory was built in 1896 to facilitate the growing interest in astronomy at the time. The total cost of the project was $15,000 and the plans entailed the twelve inch equatorial telescope, four transit telescopes, and various other astronomical equipment, including two brick piers in back for smaller telescopes already in the University's possession. The dome room and telescope were built by the highly respect firm, Warner and Swasey, of Cleveland, Ohio. The optics, a doublet, were ground by John A. Brashear, considered to be one of the finest lens makers ever.

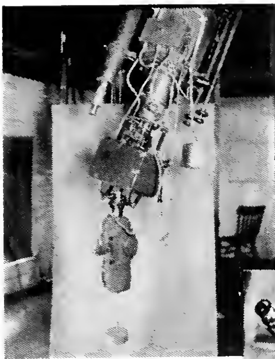


the twelve inch refracting telescope inside the dome

the Observatory

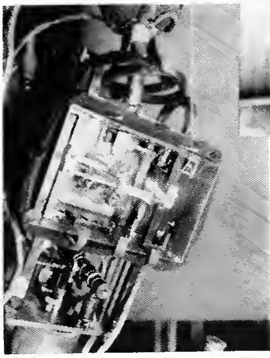
In the 1910's, Joel Stebbins did his earth-shaking work in photoelectric photometry at the Observatory. In short, he measured the brightness of stars. In short, he used electricity to measure the brightness of stars. This was the first productive work ever accomplished with electricity, and, because he was quite accurate, the work rocked the foundations of astronomy. The photoemissive cell he developed had many other benefits; using light from the star Arcturus, it started a world's fair in Chicago, and it helped start the first sound-accompanied motion picture. Today, its descendants can be found in cameras and more importantly as charged-coupled devices (CCD's) on the back end of every major optical observatory, including the Hubble Space Telescope, in the world today. Through the efforts of various groups, including notable contributions from Michael Svec of the Astronomy Club, the Observatory was put on the National Register of Historic Places in 1986, and in 1989 became a National Historic Landmark.

Mike Svec holding the landmark plaque



full view
of the
photoemissive
cell on the
telescope

close-up
of the
eyepieces
on twelve
inch
telescope



close-up
of the
photoemissive
cell holder on
the twelve inch
telescope

close-up of the
twelve inch objective

close-up
of the
photoemissive
cell

Saturn
through
the
twelve
inch
telescope

Marisa Ruffolo

TECH PROFILE

Professor Paul Lauterbur

A member of the University of Illinois faculty since 1985, Professor Paul Lauterbur currently supervises research at the Biomedical Magnetic Resonance Laboratory located at 1307 West Park Street in Urbana. His research with Magnetic Resonance Imaging has contributed greatly to science, and has brought him considerable recognition. Most recently, he was chosen from over 100 nominees worldwide to be the recipient of the Bower Award for Achievement in Science from the Franklin Institute in Philadelphia. The award is science's richest prize, including a gold medal and cash prize of $290,000.

Professor Lauterbur received his Bachelors degree in Chemistry in 1951 from Case Institute of Technology, now Case Western Reserve University, in Cleveland, Ohio. After achieving his Ph.D. at the University of Pittsburgh in 1962, he became a faculty member at the University of New York at Stony Brook where he remained until 1985.

During his academic and early professional years, Dr. Lauterbur became very familiar with Nuclear Magnetic Resonance (NMR) which, up to that point, had been used solely in spectroscopy. In 1971, however, Professor Lauterbur developed a way of using NMR signals to make images. Though the process he developed is rather complicated, the basic principles behind Magnetic Resonance Imaging (MRI), are fundamental.

The principle of NMR exploits the fact that many atomic nuclei, such as protons in hydrogen atoms, resonate at a characteristic frequency when placed in a strong magnetic field. Individual nuclei in the system align themselves at an angle with the direction of the static magnetic field and precess like a top around the direction of the magnetic field. If a radio signal of the same frequency as the precession is directed at the sample, the resonance that occurs creates bulk magnetization vectors precessing at frequencies proportional to the static magnetic fields at each location and in each particular molecular site. These can be detected by a radio receiver, digitized, and processed by a computer to give either images, spectra, or both, characteristic of the chemical composition, or both.

One application of MRI is clinical. Since it provides a means of visualizing the inside of the body, physicians can use it as a tool for non- invasive diagnoses. For this purpose, the strong signals from hydrogen nuclei in the very abundant water molecules in tissues are usually employed.

Dr. Lauterbur's current projects involve development of more detailed ways of imaging (i.e. improving resolution, 3-D images), different techniques for imaging living organisms, and new ways to measure the flow of liquids through capillaries and tissues. He is also collaborating with the bioengineering department in trying to make NMR coils which will enable very small subjects to be visualized, possibly even a single cell.

Research, however, is only one of Dr. Lauterbur's many duties. He also advises graduate and undergraduate students who are doing research in his lab, regularly lectures for Biophysics courses and occassionally in others, and participates in the usual academic committee dutes required of all faculty.

Lauterbur finds working in an academic atmosphere very exciting; "Many of my co-workers are graduate and undergraduate students. Oftentimes undergraduates are willing to take chances that others are 'too smart' to take. Their enthusiasm and willingness to tackle new things helps to provide for an enjoyable and relaxed working environment." Professor Lauterbur is able to work closely with his wife, Professor M.J. Dawson, who is a professor in the Department of Physiology and Biophysics at the University of Illinois.

Professor Lauterbur seems to thoroughly enjoy his research. He stated, "I find it very satisfying to work with many experts in different disciplines. We are always doing (or trying to do) something new as we attempt to help each other solve common problems."

Metals That Have A Memory

John W. Shirokoff

How is it that a class of metal alloys, after suitable processing, can be formed into a new shape at a lower temperature and then later "remember" to transform back into their original shape at a somewhat higher temperature?

It has long been established that metals can be improved by alloying, which involves combining pure metal and nonmetal elements into mixtures, and also by refining their processing methods (e.g. heat treating, forming, etc.). Commonly, these two approaches are used cooperatively and enhance a material's performance. The right combination of alloying and processing has led to the creation of a new class of materials known as "memory metals". Memory metals exhibit the unique ability after initial deformation at a lower temperature to "remember" (i.e. transform back to) their original shape when raised to an elevated temperature. This unusual property of shape-memory alloys offers solutions to many engineering problems.

The shape memory effect itself is only observed in certain metal alloys that can be suitably processed into a crystalline microstructure called martensite. Martensitic microstructures are achieved by quenching (e.g. fast cooling in water) a single crystal metal (of beta or parent phase material) from a high temperature, which is above a critical temperature, martensite start, or Ms, to a low temperature below the martensite finish temperature, Mf. As the metal cools from Ms to Mf it spontaneously adopts a new crystal structure (atomic configuration). This gives rise to an associated volume expansion or force within the solid. There is also a rise in elastic strain energy, coupled with the creation of defects such as twins. Briefly, twins can be thought of as bands of atomic layers in the crystal folded onto a new crystallographic plane somewhat like an accordion bellows.

The next step is to deform the martensitic metal at a low temperature somewhere below Mf. Each crystal in the metal phase is free to form up to 24 equivalent orientations (align along various planes and directions known as variants) after quenching, it is surprising to observe that only one orientation remains after deformation. Other orientations present are restricted by the existence of twins and by the movement of some martensitic interfaces. The surviving orientation of martensite crystals becomes the one that allows for shear or maxi-

mum elongation in the direction in which it was deformed. Thus, the microstructural changes are governed by the reorientation of martensite crystals.

The final process of restoring the material to its original undeformed shape requires heating of the solid such that the crystal of martensite "unshears" to form a crystal of the original parent crystal structure. In a sense, the reverse transformation of a given martensitic crystal due to heating is just the opposite of the formation process in that the martensitic solid of single orientation reverts to the original parent phase. However, none of the other twenty-three possible orientations recovered on the way back to the original shape.

A wide range of alloys have been identified and developed to exploit the shape memory effect. Some of the most commonly known metal alloy systems are as follows: Ag-Cd, Au-Cd, Cu-Al-Ni, Cu-Au-Zn, Cu-Sn, Cu-Zn, Cu-Zn-Si, Cu-Zn-Sn, Cu-Zn-Al, Cu-Zn-Ga, In-Tl, Ti-Al, Ni-Ti, Ni-Ti-Cu, Ni-Ti-Fe, and Fe-Pt.

Historically speaking, the first real reference to the bending of a martensitic material and subsequent heating to return it to its original shape was initially discovered for Au-Cd alloys by L.C. Chang and T.A. Read. Later developments were noted on the first Au-Cd heat engine application by T.A. Read in 1958 at the University of Illinois, and the origin of Ni-Ti (Nitinol) alloys by W. J. Buehler of the U.S. Naval Ordinance Laboratory (US-NOL) in 1962. Hence, the name Nitinol was coined from the letters of the metal elements and the naval laboratory in which they were discovered Ni-Ti-NOL. The engineering value of these Nitinol alloys proved to be particularly useful since their transformation temperature could be adjusted within the temperature range of -100 C to 100 C by alloying. They gained entry into the aerospace industry initially in such applications as latch releases for activating instruments on a British

satellite, and later as a tubular coupling used to join titanium hydraulic tubing in the Grumman F14 navy jet fighter. They were also developed by Goodyear Aerospace to unfold in wire mesh form as a spacecraft antenna net.

Past and present trends for shape memory alloys seem to indicate that they are being increasingly developed for wider industrial, energy and medical uses. Some of the important industrial applications include plumbing fixtures on subsea pipe and submarines, heat-shrinkable fittings, clamps, electrical plugs, thermostats and rivets. The primary energy application has been focused on utilizing the shape memory effect between two fixed temperatures to create a mechanical force which can do work in a heat engine. Other exciting developments are known to exist in the medical/dental field. These include orthodontic dental arch wires which require fewer arch wire adjustments, blood clot filters that can take shape within a warm vein after insertion by a catheter, and aneurysm clamps used to tie off bulges in arteries that are heat releasable. For example, temperature sensitive orthopedic implants that contract on localized heating fit fractured bones more securely together. An interesting consumer application would be the shower guard anti-scald safety valve. This temperature sensing valve can protect consumers against hot water scalding by instantaneously closing when its temperature sensitive shape memory alloy transforms upon heating.

One final application can be found in Professor C. M. Wayman's laboratory, University of Illinois--a mini-robot. Wayman and his colleagues have developed a two-dimensional x-y robotics positioner which is accurate to ± 0.1 micron for a movement of 70 mm, or 0.0014%. The motion control is achieved by resistance heated coil springs made of Nitinol which are counterbiased with steel springs. Robots with three-dimensional movement, such as the one shown in the photograph, have also been developed, but they are not as precise. Memory metal actuated robots need only be one-tenth the size and weight of conventional servomotor robots, and thus can be readily placed in inaccessible and hazardous environments.

Tech Teasers contest

1. In the following equation, each letter represents a digit (0-9). Find what digit each letter represents.

```
    E A S T
    W E S T
  S O U T H
+ N O R T H
-----------
  E A R T H
```

This problem is worth $15

2. Find d for the following equation:

$$a3bd = c^2$$

This problem is worth $25

see page 16 for rules

Kara Federmeier

CELLS HELPING CELLS

Understanding How Differentiation Of Cells Is Affected By Other Cells And Their Environment

Lawrence Berkeley Laboratory in Berkeley, California, is well known for its prominent position in the international effort to map the human gene, the Human Genome project. What is less well known, however, is some of the other important biological research carried on at this facility — research that is making important strides toward the understanding of human physiology and pathology. An example of this research is the work done by Mina J. Bissell and colleagues on the extracellular matrix and its role in cell differentiation.

Since the early 1900's, scientists have suspected that interactions between adjacent tissue groups during development produce variations in cell types. Current scientific knowledge holds that these interactions are fundamental for the creation of differentiated tissues. However, most of the documented cellular changes have involved cell structure rather than cell function. Rare, but impressive, are the studies of functional changes in a cell as a result of a change in the cell's environment. Studies by Dr. Bissell and her research team probe the very question of what causes these changes, both functional and structural, and how such knowledge can affect the future of biology and medicine.

The primary focus for research on cell growth and differentiation is the cell culture. Cell culture studies have greatly increased our understanding of cell and tissue interactions. The different types of cell cultures and the resulting changes in cells grown in these cultures dramatically illustrate the importance of cell interactions. The most common type of cell culture used in biological research involves the plating of cells on flat plastic or glass environments. A cell grown in such a culture tends to line up with the other cells, but grow separately from them and rapidly lose almost all traces of differentiation, so that cells from different parts of the body begin to function similarly. A second type of culture, the floating gel, produces similar results. Here again, the cells line themselves up, this time on the gel, and tend to function individually. Once again, the cells lose most of their differentiated functions and structures. A third, and newer, type of cell culture places cells in the environment of an extra-cellular membrane (known as an EHS matrix) where they have more freedom of movement. The growth differences in this type of cell culture are striking. The cells begin to cluster together, wrapping the membrane around the outside of the cell group. This cell cluster and membrane functions as a single unit, and cells retain their previous differentiated status. While no definite conclusion can be drawn from this correlation, these results seem to suggest that cell interactions play an important role in cell differentiation.

Research done at Lawrence Berkeley on the mammary cells of mice in these varying cell cultures exemplifies the changes in cell types as a result of the cellular environment. Mammary cells from pregnant mice were plated on plastic and floating gel environments, and, in every case, these cells lost their secretory morphology and their lactating-oriented biochemical properties. When grown in a interactive cell environment (such as an EHS matrix), however, these cells retained their structure and most of their biochemical properties. In fact, when placed in such an environment with lactating cells, even mammary cells from unimpregnated mice appear to function in a similar manner as the mammary cells from the pregnant mice. While it would seem that many factors could cause this change, research teams have tested the effects of nutrients, close cellular proximity to the medium surface and gas phase, interaction of cells with stromal elements, and the flexibility of the substrata, and have shown that none of these factors alone are sufficient to produce the differentiated results. Indeed, then, cell to cell interaction seems to be an important, if not the primary, factor in determining cell differentiation.

The extracellular environment seems to influence not only the structure and biochemical function of a cell, but its very genetic functioning as well. Research has shown that cells in a suspension culture show a rapid decrease in protein synthesis, indicating the withdrawal of mRNA to an "untranslatable" status. These same cells placed into an environment which allowed attachment to a substratum showed a rapid increase in protein synthesis. Even after new mRNA synthesis was inhibited with actinomycin D, the protein synthesis levels continued to rise as compared to those observed in the suspended environment. It can be concluded from such studies that attachment of the cells to the substratum is necessary for translational control to occur. Another group of experiments has shown that cytoskeletal elements help to modulate the ability of mitogens to initiate DNA synthesis. Thus, the

cell's ability to interact with surrounding tissue seems to have a definite affect on the type and quality of its genetic functioning.

The results of work done at Lawrence Berkeley and other labs have led Dr. Bissell and her colleagues to propose a model which explains the "dynamic reciprocity" between the cell and its matrix. This model suggests that the cell and its environment mutually affect one another's growth and functioning. The extracellular membrane affects the cell which in turn responds chemically, causing the composition and structure of the membrane to change, which again influences the cell, etc. According to this model, cells alone do not function differentially—they rely on other cells and chemical to function in their specialized roles. How do other cells and the extracellular membrane affect the differential functioning of cells? Much research is still needed to make any definite conclusions, but it seems fairly definite that it is direct contact of the extracellular membrane (or certain components thereof) with the plasma membrane of the cell which brings about the net change. Whether this contact involves covalent binding to plasma receptors or whether some type of non-covalent interaction is involved is the subject of current and future experimentation.

The implications of this research for biology and medicine is far-reaching. For example, a new theory about the cause and growth of cancer has come from such differentiation research. It has been suggested that cancer can be caused by poor cell specialization or lack of specialization at all. Experimental evidence for this claim comes from several sources. One type of experiment involves the transfer of tumor cells to embryonic chicken tissue. Embryonic tissue differs form developed tissue in that embryonic tissue contains little, if any, specialization. Tumor cells which would have readily created tumors if injected into developed tissue created no cancerous effects in the embryonic tissue. It is postulated that this difference in tumor growth results because tumor tissue is more like embryonic tissue than developed tissue—that is, that tumor tissue is poorly differentiated. These results seem to imply that cancer cells in the right environment can become normal, and thus that the environment in which a cell is placed has a profound impact on whether or not the cell will become tumorous. The idea that cellular environment can influence the growth and development of cells, and the implications of this for cancer research, has been investigated in another set of experiments on chickens. Tumor tissue was injected in to the wing of a chicken. A tumor developed where the injection had taken place, but no other tumors were found. If, however, a wound was made in the chicken's other wing, a tumor would quickly develop. It would seem, then, that the wound healing "environment" is a prosperous one for tumor growth; this may be because it is during new cell formation that tissue becomes specialized and is therefore prone to bad differentiation. If the process of wounding and wound healing is then a ripe environment for the growth of cancer cells, many current cancer treatments (surgery especially) could, in fact, be doing more harm that good, especially when the tumor being treated is suspected to be benign or causes no definite harm to the individual. In those cases, removal of the tumor and the resultant wounding of the surgery could, in fact, make the individual even more prone to developing a malignant cancer. If further research substantiates the results of these experiments, a whole new process of cancer treatment could be developed, with an emphasis on changing the environment of the tumorous cell in hopes of changing the cell's differentiation and resulting function.

Cellular environments, therefore, will be the subject of many more crucial research projects. The influence of the extracellular matrix on the cell (and the cell's further influence on the extracellular matrix) seems fundamental to the process of differentiation, a process which is crucial to biological functioning. It has been shown that differentiation plays an important role in cell structure and function as well as genetic operations; moreover, such specialization (or lack thereof) may influence cancer and other diseases and even control the process of aging. The "dynamic reciprocity" model may thus hold the key to a better understanding of cellular processes and the specialized functioning of tissue. This, in turn, could help create better methods of disease control, and lead to a more complete knowledge of the very essence of life itself.

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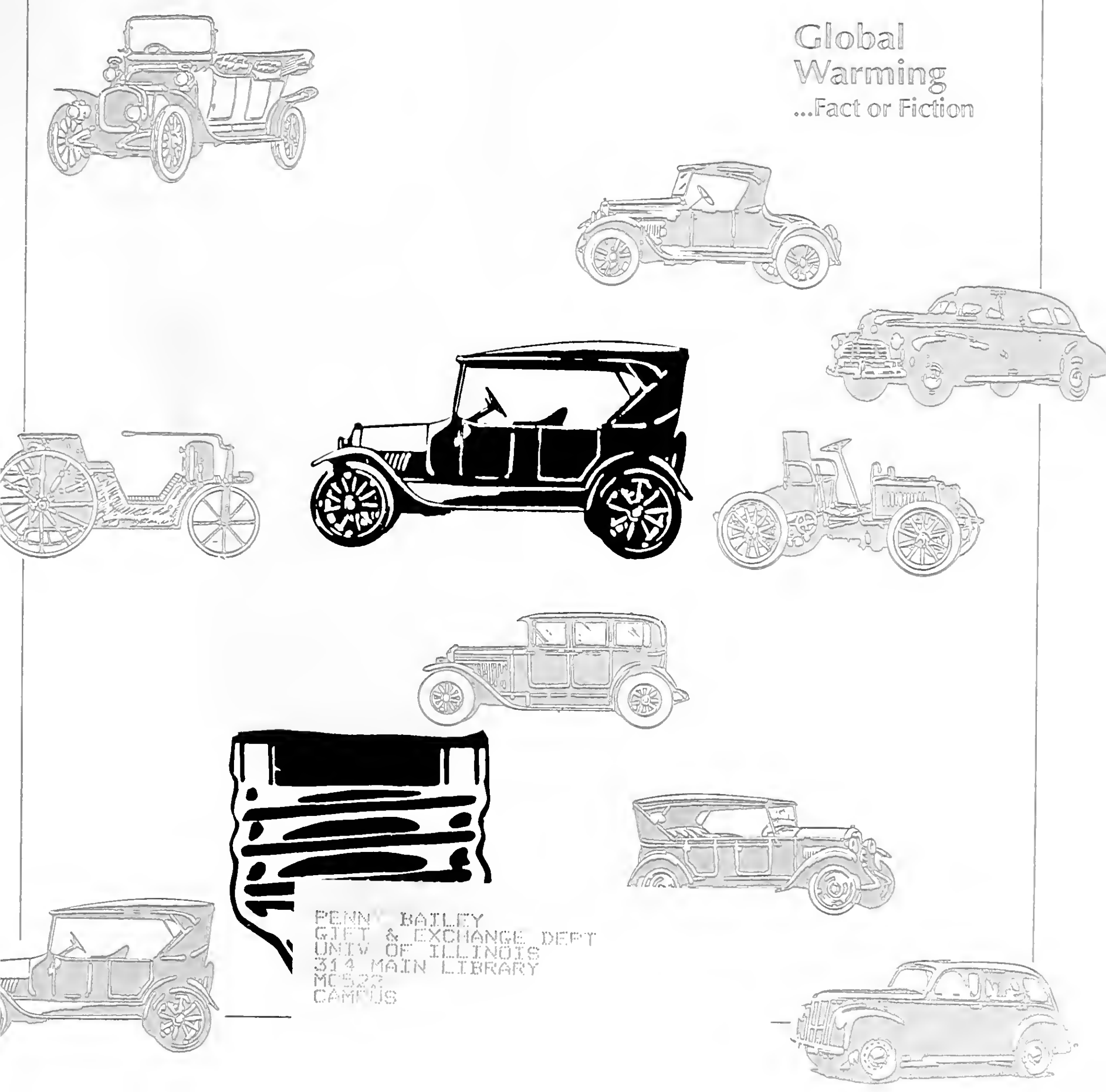
Global Warming ...Fact or Fiction



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editor's remarks

John Fultz

Once again, folks, we have dared to include an environmental article within these pages. Some may wonder why we view the environment as an appropriate topic to cover repeatedly within the pages of an engineering magazine. Well, if you think it over a bit, you will realize that the root of all environmental evil often starts with us, the engineers.

Well, I suppose engineers can not be completely to blame for the oil-driven automobiles, jet airplanes destructive to the ozone layer, or construction of factories which contribute so much to the smog that literally chokes many people who live in metropolitan areas today. We can not be fully responsible for an America that thrives on electricity or electrical plants which thrive on oil and coal. Certainly employers, the government, and even the almighty consumer have determined our actions in part.

Nobody is stopping us from speaking up, however. Nobody is stopping us from informing America how much it is hurting itself in the long run. Nobody is stopping us from telling people about the dangers of fossil fuel dependence or toxic waste dumps. Nobody is stopping us from fixing the very problems we create.

So what is my message? Think about what you do and act responsibly in your work because you are responsible. Become more informed about environmental concerns and how you can help. Maybe you could even spare a little time for activism.

This country is now considering going to war over oil, an energy supply which could possibly destroy our environment if its supplies do not run out first. Consider what you can do.

Tech Teasers contest

1. A marching band wants enough people to form two perfect squares in eight twelve different ways. What is the smallest number of members the band needs if all members are to be used every time?

This problem is worth \$25.

2. Find a perfect square which is still a perfect square when you add five to it or subtract five from it. This problem was given to Leonardo Fibonacci at a math tournament by Roman Emperor Frederick II.

This problem is worth \$25.

see inside back cover for rules

last issue's TechTeaser solutions

1. Although there were multiple answers to this problem, only one was required to get it right. Eric Ziegler, junior in Mechanical Engineering, won \$15 for his answer to the problem. His answer is as follows:

A = 6, E = 8, H = 4, N = 4, O = 1, R = 7, S = 3, T = 3, U = 5, W = 4

```
      E A S T           8 6 3 3
      W E S T           4 8 3 3
    S O U T H         3 1 5 3 4
  + N O R T H       + 4 1 7 3 4
  -----------       -----------
    E A R T H         8 6 7 3 4
```

2. Due to an error on our part, the problem as stated was incomplete. We apologize for any inconvenience this may have caused.

the correct problem should have been: $ab3d=c^2$

The problem is in octal, and c can be a 2 digit number. What is d?

The correct answer is d=1.

Global Warming

As early as 1896, the Swedish chemist, Svante Archenius, predicted a global warming of about eight degrees Celsius resulting form a doubling of carbon dioxide in the atmosphere. At that time, before the public health, transportation, and communications revolutions, his dire warning had little effect on the scientific community or the population in general. One hundred years later, however, carbon dioxide and other gaseous emissions and their possible effects on our fragile atmosphere has become one of the most hotly debated economic, political, social, and scientific topics of the decade. The issue is clouded with speculation, doubt, and even outright exaggeration – misinformation that forms the basis for scientific studies and political and economic policies. Certainly, the issue of global climate change is too complex to be dealt with in its totality, but this article seeks to outline some of the main points of the debate, the possible consequences of human-induced climate alterations, and some available solutions to the problem.

Despite all the talk about ozone depletion and the greenhouse effect, many prominent, respected scientists are not yet convinced that global climate change is an issue at all. None deny that the climate is changing and will continue to change. As Peter Rogers of Harvard University states in his article, "Climate Change and Global Warming,"

> *That the climate is going to change is one of the few things we can be certain about. Historical records show that the temperatures have been higher and lower, and places have been wetter and drier that they are now.*

How much of this change will be caused by human factors, however, is the real point of argument in the scientific community. Ice core data collected from the past 150,000 years shows simultaneous increases and decreases in carbon dioxide concentrations and temperatures taking place at periods when anthropogenic contributions were only negligible. It cannot, therefore, be taken as fact that the recent increase in atmospheric carbon dioxide – without any significant temperature change – is not simply part of the natural fluctuations of atmospheric composition.

On the other hand, given the steady increase of carbon dioxide concentrations from 1958 to the present, correlated with the steady increase of industry and technology, it seems difficult to assert that human progress is having no effect on the atmosphere whatsoever!

Another problem is that, even assuming global climate change is imminent, no accurate predictions can be made about exactly what these effects will be. For example, in computer projections of annual rainfall changes (assuming a doubling of carbon dioxide concentrations), the Goddard Institute for Space Studies reported a potential change of about -.25 millimeters of rainfall per day in the Great Plains area, while a similar prediction from the Geophysical Fluid Dynamics Laboratory gave the change as about +.6 millimeters per day!

Also, despite all the apocalyptic warnings which foresee Florida and Washington D.C. engulfed in water, there are those who can even find some good in global climate change. Robert M. White writes in **Scientific American**, "Some aspects of global climate warming would be greatly beneficial in the view of agricultural researchers. Increased carbon dioxide would foster more active photosynthesis and enhance crop growth, to say nothing about lowered plant requirements for water in a carbon dioxide-enhanced atmosphere."

Thus, little consensus can be found about global climate change or even its potential effects. There is, however, some agreement among scientists about the possible problems that specific aspects of climate change could cause. For example, if the atmospheric concentration of carbon dioxide were to double (whether through natural or anthropological causes), the National Academy of Sciences gives the following predictions:

1. Large stratospheric cooling (virtually certain) – reduced ozone concentrations in the upper stratosphere would lead to reduced absorption of solar ultraviolet radiation and thus reduced heating of the earth's atmosphere.
2. Global mean surface warming (very probable) – increased greenhouse gases would raise the temperature of the surface form 1.5 to 4.5 degrees Celsius.
3. Global mean precipitation increase (very probably) – increased heating of the surface would lead to increased evaporation and therefore to greater global mean precipitation

(though some areas could experience decreases in rainfall).
4. Reduction of sea ice (very probably) – as the climate warms, total sea ice would be reduced.
5. Polar winter surface warming (very probably) – as the sea ice boundary is shifted pole-ward, models predict a dramatically enhanced surface warming in winter polar regions (perhaps by as much as three times the global mean warming).

Kara Federmeier

. . . Fact Or Fiction?

Obviously, even conservative estimates for increases in one greenhouse gas show a dramatic climate change in the planet's future. When all the other factors (other greenhouse gases, rain forest clearing, etc.) are considered, it is not difficult to see why global climate change has become an issue of magnitude. Despite the fact that scientists are not in agreement about the roots of these changes, it seems that even the possibility of human causality would merit some reconsideration of current environmental and social behavior. In addition, depleting fossil fuel supplies and the associated political problems makes energy conservation important for more than atmospheric reasons! Unfortunately, the alternatives suggested by many extreme environmental groups often turns the average citizen away from conservation, and subsequently, the public stays ignorant of more conservative, scientific methods of energy regulation.

Science has, however, made great strides in the area of energy management and conservation. These advances would allow the individual citizen, not to mention large businesses and industries, to implement technology which would benefit the environment, save energy, and cost less. To see what kind of effect implementation of this technology could have, consider the use of two of these new devices: the compact fluorescent lamp and low energy window technology.

The energy saved over the lifetime of one compact fluorescent lamp is equivalent to 40 gallons of gas or 1000 miles of driving. The cost of a compact fluorescent lamp plant is $7.5 million (compare to 750 million of ran offshore oil platform). An average plant can produce 1.8 million compact fluorescent lamps yearly for 10 years, and the amount of energy such a plant would save corresponds to enough jet fuel to fly a fleet of 6 Boeing–757 airplanes continuously around the globe carrying 1,122 passengers for the life of the plant. In addition, producing compact fluorescent lamps is 30 times cheaper than continuing to produce incandescent lamps. These lights cost the consumer considerably less in the long run, provide light with less glare for the eye, and last longer than incandescent bulbs (one compact fluorescent lamp can replace twelve 60 watt incandescent bulbs over its lifetime). They fit into standard light sockets, so they are not only cheaper and energy efficient, but also immediately practical!

Low energy window technology also yields surprising and far-reaching energy statistics. For example, an $8 million dollar investment in a low-energy coating system will coat 20 million square feet of windows per year for the ten year nominal life of the coating system. The resulting energy savings corresponds to 36 million barrels of oil (a cost of $300 million dollars). Again, this energy conservation system is practical and immediately applicable.

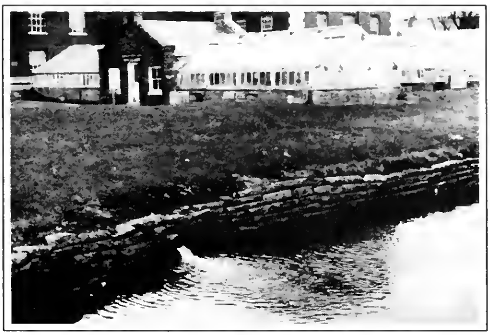
These are only two of many currently available energy-conservation systems, but they help clarify how scientific advances have made energy conservation and, perhaps, a reduction of the human contribution to global climate change, a practicable reality. In addition, further advances in nuclear and solar technology could well revolutionize the attainment and use of energy. It takes only a willingness on the part of the business or consumer to make appropriate changes in their behavior. Although there is no guarantee that such measures will slow the process of global climate change, there is no reason not to implement technology which is cheaper, more efficient, and ultimately better for the environment.

There seems to be no foreseeable end to the debate over the causes and effects of global climate change, as current models are simply not able to deal with a system as complex as the global environment. There is strong evidence, however, that climate change will be an issue in the future of the planet, and, until the fact are known, it would seem foolish to take no preventative measure. Science cannot tell the people of this planet what lies in store for them, but it can offer solutions which might help slow human damage to the environment. When the solutions science offers are both cheap and practical, why wait another hundred years to heed the warming signs?

TECH VISIONS

Boneyard Portrait

The Boneyard Creek has often been in the news during this semester. People have reported finding oil and other toxic materials in it. Even water has been found in it. The city has cleaned spills and debris from it, yet it still haunts us with the rumor of its eery glow at night and the reality of the never-ending garbage which pollutes it. Here is an untainted portrait of the Boneyard from beginning to end, although we have yet to capture the glow in photos.



photos courtesy of John Fultz

Mark Maslov

TECH PROFILE

Professor Steven S. Zumdahl

Most professors at the University of Illinois do not work here just so that they can teach. For some of them, it is a good thing they do not; their lectures are often somewhat less than inspiring. They may be knowledgeable professors and good researchers, but they are not necessarily first-rate educators. Thus, if you happen to get a professor who enjoys teaching and is good at it, you are very fortunate. Professor Steven S. Zumdahl is one of that rare breed of professors who takes pride in being a good teacher.

Dr. Zumdahl chose to study chemistry because it was a subject he liked in high school, and he decided to give it a try in college. He admits that at the time, he didn't know where it would lead. During college, however, chemistry grew on him. One reason Zumdahl enjoys chemistry is because it is challenging. He also likes the models chemists have invented to help explain things, and it is easy for him to find examples of chemistry in everyday experience. "Chemistry is all around us," Professor Zumdahl said.

Dr. Zumdahl received his Bachelors of Science in Chemistry from Wheaton College. He then got his Ph. D. at the University of Illinois in Champaign/Urbana. Zumdahl held his first teaching job at the University of Colorado in Boulder, where he spent six years. While at Boulder, it became clear to him that he wanted to continue teaching. An opportunity arose to teach freshman-level chemistry here at the University of Illinois, and Professor Zumdahl has been teaching here ever since. He is now the Director of the General Chemistry Program.

Although Professor Zumdahl doesn't do research like most professors, this situation allows him to concentrate on his other scholarly activities. A task that he finds pleasure in is writing textbooks. The one University of Illinois students are probably most familiar with is **Chemistry**, which is used in freshman-level chemistry courses here. He is currently working on another writing project. Zumdahl says that writing is not only enjoyable, but it also makes him a better teacher.

Professor Zumdahl's biggest accomplishment is his teaching. He tries to get across to his students the same aspects of chemistry that inspire him. "Teaching students is what I like the most. And the fact that students think I do it well is what I am proudest of," he said. For his teaching ability, Dr. Zumdahl has received the University of Illinois Award for Excellence in Undergraduate Teaching in 1981 and three School of Chemical Sciences Teaching Awards.

Yet the greatest reward for Professor Zumdahl is the reaction he gets from his students. It seems that on the whole, his students think he is an excellent teacher. Todd Miller, a sophomore who took Dr. Zumdahl's CHEM 107 last year, commented that attendance is high in Zumdahl's class because his lectures are so interesting. Sometimes he uses examples to explain things that are based on his outside interests such as restoring classic cars. Also, Professor Zumdahl cares about his students. He tries to get to know each student by name, and students find it easy to talk to him one-on-one outside of class. Todd explains that he learned so much in CHEM 107 that he didn't care what grade he got. "People who didn't get him missed out," said Miller.

Teaching is important to the quality of undergraduate programs, and Professor Zumdahl is clearly doing his part in making general chemistry an outstanding program at the University of Illinois. Faculty members like Professor Zumdahl are an asset to the university.

And Now We Use Light

Masahiko Noda

"A picture is worth a thousand words" - this saying is no less true for scientists than it is for the rest of humanity. Developing safer methods and creating more accurate pictures is a major scientific endeavor.

The invention of the light microscope in the 17th century resulted in the discovery that living organisms are composed of many cells. Subsequently the light microscope became an indispensable tool for medical and biological research.

The need to observe even finer details eventually led to the development of the electron microscope, which uses a high-energy electron beam with a shorter wavelength than visible light. Recently we have even been able to see atoms. Prof. W.K. Röntgen's discovery of the X-ray at the end of the 19th century made new pictures possible: X-rays could be used in clinical diagnosis to see bones and organs.

The development of computers has enabled the modern scientist to see the insides of his/her patient in three dimensions. The CAT (computerized axial tomography) scan is a diagnostic technique in which a number of images taken from different perspectives are combined to form a computer created cross-sectional image.

In addition, there is the laser. Developed in the mid-20th century, a laser emits a visible beam of highly concentrated light of a signal wavelength and direction. You could bounce a laser beam from the earth off a mirror set up on the moon, and it would come back straighter than an arrow.

Pursuing picture-making research from a different perspective is Prof. Fumio Inaba at the Research Institute of Electrical Communication at Tohoku University. For the last 20 years he has been working on the detection and applications of ultra-faint light.

In 1986 he became research leader of the ¥2 billion ($13.5 million) Inaba biophoton project, one of the Exploratory Research for Advanced Technology (ERATO) programs promoted by the Research Development Corporation of Japan. Research focuses, not surprisingly, on biophotons—very weak light invisible to the human eye, which is emitted from tissues and cells.

Research on light emitted from within living organisms has branched out into research on the detection of light transmitted through the body. If such light can be detected, we will be able to see through living things as well as produce cross-sectional images of living organisms. Different wavelengths will yield different types of information; this flexibility makes the optical CAT scan a potentially awesome technology.

There are four prerequisites to the realization of this technology;

(1) *Confirmation that light can pass through living organisms.*

People are 70% water; they also have pigments such as melanin in their skin cells and hemoglobin in the red blood corpuscles. The problem is finding a type of light that will pass through all of these. Water absorbs ultraviolet light but transmits visible light; pigments absorb blue light but transmit red light. It has been discovered that a near-infrared light (with a wavelength of 0.6 - 1.1 μm) passes through the body in infinitesimal amounts.

(2) *The ability to detect and glean information form light transmitted directly through living tissue.*

The Inaba group has developed a system they call coherent detection imaging (CDI). Laser beams of slightly different wavelengths are superimposed and transmitted through the tissue. The difference in wavelengths shows up as light and dark zones that appear cyclically; the cyclical pattern provides a steady gauge against which any diffraction occurring during transmission can be measured. Researchers can, in other words, distinguish laser beams which pass straight though the tissue from those that are internally diffracted.

(3) *Assurance that transmitted light carries accurate information.*

The CDI method depends on the Lambert-Beer law—the density of bodies is directly proportional to light absorption. It had been though that the law could apply only to low density liquids and gases but it has since been proven that it applies equally to solid bodies irradiated with laser light.

(4) *Proof that light passes without bending through living organisms.*

Until recently, perhaps few people imagined that light could pass straight through living organisms. Since living things are composed of more than one type of material it made sense that light passing through would be diffracted and bent. However, experimentation has shown that some kinds of light pass straight through living organisms.

Light is safe effective and flexible; the successful optical CAT scan demonstrated by the Inaba group in May at a briefing session of ERATO will undoubtedly be the technology of the future.

NANOCRYSTALLINE MATERIALS

John W. Shirokoff

Nanocrystals represent a new class of ultra-fine grained materials identified as having novel and often improved properties when compared to conventional crystalline materials.

Since the turn of the century, it has been known that the atomic structure of conventional crystalline materials deviates somewhat from perfect order. This lack of perfection in nature is due to the incorporation of defects such as vacancies (missing atoms), dislocations (a shifted row of atoms) and grain boundaries (the misoriented planar structures forming the borders between grains). The control of these and other defects, and the relationships of these defects to the properties of materials, has long been a major focus of materials research. Perhaps the most important defects in the microstructure of polycrystalline materials are its grain boundaries. They strongly control the relationship between structure-property and performance by breaking-up the perfect symmetry of the lattice. Thus, the design and control of grain boundaries is crucial to the development of high performance engineering materials with desirable properties.

Grain boundary engineering includes the control of grain growth, grain size and type. It has been most successfully utilized in the engineering of metals and alloys. However, when this approach was applied to engineering brittle materials such as ceramics and intermetallics the results were much less spectacular. In short, the problem of ductilizing brittle materials became a complex one which required a greater understanding of the field of fracture mechanics in solids and ultimately the advent of new approaches to find a workable solution. Recently, the idea of creating nanocrystalline materials proved valuable in this regard.

A nanocrystalline material is one which has grains so small (nanometer = 10^{-9} meters) that 25% or more of the atoms are typically located on the grain boundaries themselves. The local environment of these atoms, i.e., short range order, is far different than in the grain interiors and this leads to dramatic changes in properties. For example, because the atomic arrangements in the grain boundaries are not as tightly packed as in the perfect lattice, atomic transport is greatly facilitated along these rather open boundaries. As one can imagine, this can have enormous significance in the deformation of solids. Consider, for example, stacking many small cubes together to form a large cube. If one now presses on the top of the large cube, it will begin to deform by atoms on the top and bottom plane of each small cube diffusing along the cube interfaces to the sides of the cubes, flattening each small cube (and the large cube). The larger the number of cubes, the shorter the distance needed for travel and the greater the number of sides taking part. So it is in nanocrystalline materials. The exact dependence of the deformation rate on grain size is, in fact, (grain size)$^{-3}$, so that reducing the grain size from microns to nanometers increases the deformation by nine orders of magnitude!

Improvements in the sinterability of nanocrystalline materials occur for similar reasons. Here, atoms flow along grain boundaries to fill the pores which are located at interparticle boundaries. One example that demonstrates the improved sinterability and ductility is nanocrystalline TiO_2 (rutile). Under normal atmospheric pressures, rutile has been shown to sinter at ~500 °C lower temperatures in the nanocrystalline form than in the conventional, coarse grained form. Besides the advantage of lower sintering temperature, nanocrystalline processing also eliminates the need for sintering aids (additives) which often cause high temperature brittleness. Furthermore, when pressure-assisted sintering is performed, the sintering temperatures can be further reduced.

The synthesis of nanocrystalline materials may involve a wide variety of processes in order to generate the small clusters of atoms that make up the individual nanocrystals followed by sintering. In general, these processes fall into three broad categories: vacuum, gas - phase and condensed-phase synthesis.

The most common method of producing nanocrystals is to use gas-phase synthesis methods which use resistive joule heating to vaporize metals in an inert gas buffer while under ultra high vacuum conditions. This system offers several advantages in processing. First, it's vacuum system ensures the condensation of particles free from surface contamination (impurities). This is actually an essential requirement for the production of cleaner grain boundaries and the subsequent reduced possibility of forming undesirable compounds during sintering. Secondly, it allows for co-deposition of species in the inert gas atmosphere and proper mixing prior to their collection. However, this last advantage is difficult to control effectively since the partial vapor pressures of the components are often different.

Unique to Professor Averback's group in the Materials Research Laboratory at the University of Illinois at UC is an ultra high vacuum apparatus dedicated to the production of nanocrystalline materials that uses a magnetron sputtering system. This novel production method provides greater versatility of the deposited material and improved control of the species being deposited. This was achieved by developing a technique that works at high inert gas pressures (0.1 - 1.0 mbar of Ar gas). Furthermore, by operating a magnetron in the radio frequency mode, ceramic powders have been directly synthesized with a particle size of 10 nm. Direct synthesis offers the added advantage of combining two process steps, metal powder synthesis and oxidation, which increases efficiency, but more importantly, greatly increases the variety of materials that can be synthesized by nanocrystalline processing. At UIUC this system has been used to produce pure metals, alloys, ceramics, intermetallics, composites and metallic glasses. Research studies so far have indicated that there is a promising future for this new class of engineering materials owing to their novel properties and often improved processing features. However, there is a need to further characterize and explore structure-properties in the new materials before their full technological potential can be realized since fundamental concepts that apply to coarser grained materials do not always apply to nanocrystals.

Thomas E. Glenn

From The Dean's Chair

Where Will You Be Ten Years From Now?

Ever ask yourself, "Where will I be ten years from now?" Seniors probably ask that question more often than others because they are going through the interviewing process and are seeking their first "real" job. Although it is quite obvious that nobody really has the answer to that question, the College of Engineering is able to provide some information as to where our alumni are ten years after they graduated.

Since 1956, the Engineering Placement Office (EPO) has been surveying BS alumni five years and ten years after their graduation. In addition, the EPO has recently initiated an annual survey of alumni 20, 25, and 30 years after they earned their BS degree. Let's now take a look at the responses of 394 alumni from their 1979 graduating class of 992 engineers.

The most asked question about the progress of our graduates ten years later is in regard to their salary. The average starting salary of the class of 1979 was $18,300 per year. Ten years later, the average salary was $50,592. With regard to curriculum, the highest paid were the computer engineers earning an annual salary of $57,360, where as the lowest paid were the agricultural engineers with an annual salary of $43,128 per year.

Another question often asked is how many of our alumni go on to continue their education? Fifty percent of our 1979 alumni had either earned or were working on another degree. Among this class, 4% were involved with a Ph.D. program, 36% were involved with a master's program, and another 10% were involved with a second bachelor's program.

Although nearly half of our graduates continued their education, not all of them received another technical degree. Twelve percent of the respondents earned an MBA. One person earned a law degree and two people completed a MD degree. It is interesting to note that the two doctors earned their bachelor's degree in Engineering Physics and the lawyer earned a bachelor's degree in Agricultural Engineering. The greatest number of MBA's were alumni of Civil and Electrical Engineering.

Another interesting bit of information about the class of 1979 is the number of engineers who have changed jobs. Of this particular class, 45% of the alumni still work for their original employers. Twenty-six percent of the alumni had one change of employer, 17% had two changes, 8% had three changes, and 5% of the class had four changes or more. It is obvious from the data that making a few changes in employment yielded a slightly higher salary; however, an excessive number of changes in jobs was not beneficial. The average annual salary for those making no changes was $50,304 while those making one change were earning an annual average salary of $49,824; those with two changes were earning $51,648; those with three changes were earning $53,424; and finally, those with four or more changes had an annual salary of $49,488.

As most of our undergraduates come from Illinois, one would probably expect that most of them would remain in Illinois for employment. Of the class of 1979, 44% of our graduates were working in Illinois ten years later. The second leading state was California with 12% followed by Texas with 6% and Missouri with 3.7%. The alumni in the class of 1979 were working in every state except for Iowa, Oklahoma, Vermont, and West Virginia.

The graduates of 1979 were employed by companies of all sizes; however, most of them were in the very large companies. Of those responding to the survey, 9% were working in companies with 51 employees or less while 47% were working for companies with more than 10,000 employees. The companies employing 5 or more of our alumni were AT&T, Bell Labs, Caterpillar, Commonwealth Edison, Digital Equipment, General Motors, Hewlett Packard, IBM, Illinois Department of Transportation, McDonnell Douglas, Motorola, Northrup, and Rockwell.

From their responses, the college also learned that 85% of our graduates felt that it was important to have an engineering degree for their present position. With regard to the number of hours spent on the job each week, 20% spent 40 hours or less, 61% spent between 41 and 50 hours, and 19% worked more than 51 hours. Ninety-five percent of the alumni felt the engineering field offered a promising future and would encourage a capable high school student to choose engineering as a career. Eighty-nine percent of our alumni found their work in the engineering field to be personally satisfying. As for professional registration, 28% of the alumni had received their Professional Engineer Registration, 20% had taken the EIT exam and had not pursued the PE, and 2.4% of the graduates were licensed structural engineers.

Although we can not look into the future as to what any individual will be doing ten years from now, the past alumni of the College of Engineering have been quite successful. The alumni of the class of 1979 have progressed very well in salary, have found their work personally satisfying, see their future to be promising, and view their BS degree as only the beginning in a career of learning.

Thomas E. Glenn is an Assistant to the Dean of the College of Engineering

Tech Teasers Contest

Rules: The problems on page 3 of this issue could win you money! All you have to do is mail your answer(s) for either problem, name, address, and phone number to the following address:

Tech Teasers Contest
Illinois Technograph
Illini Media Company
57 E. Green St.
Champaign, IL 61801

The first person to submit a correct answer for each problem will win the amount specified for each problem. In case of a tie, a name will be drawn to determine the winner. This contest is not open to employees of Illini Media Company.

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TECHNOGRAPH

Vol. 106
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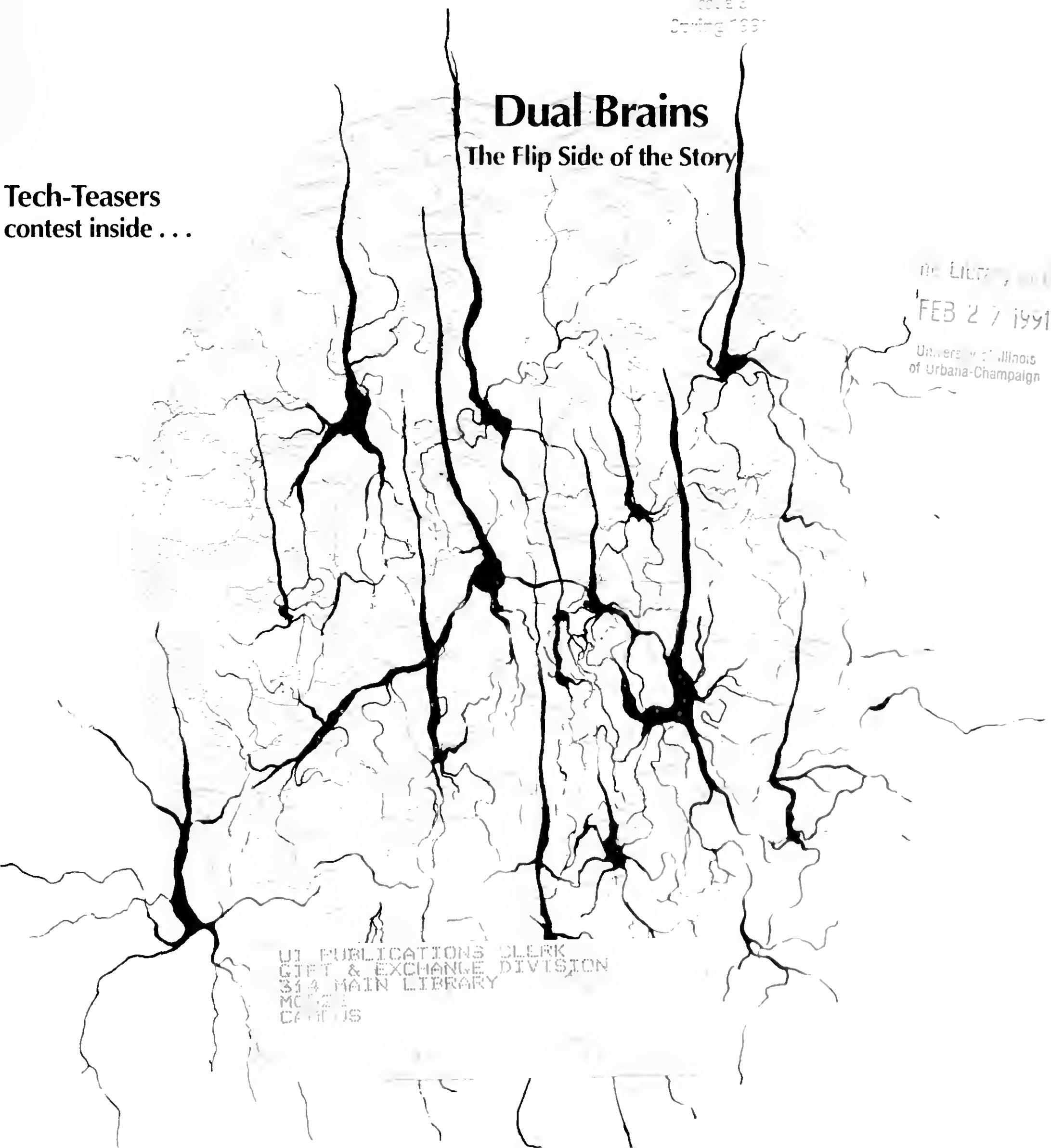
Spring 1991

Dual Brains

The Flip Side of the Story



Tech-Teasers contest inside . . .

Do you have any writing skill? *If so, we can use your talent. The Technograph always has positions open for regular writers. The Technograph also accepts freelance submissions for people who only have the time for a single submission. We accept articles on most engineering and science related topics, and we encourage engineering graduate students to write about the projects they are conducting. For more information, contact John Fultz at 332-4071, or Chi-Ting Huang at 328-6808. You may also leave a message at Illini Media, 333-3733.*

ILLINOIS
TECHNOGRAPH

spring 1991

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editor's remarks

John Fultz

In the United States of America, we like to think we are on the cutting edge of technology. Sure, we may be a bit behind the Japanese in some areas, but technological advancements seem to come along a dime a dozen these days, don't they? Well, let's take a look at some of the major advancements over the years.

Major American companies are begging our government to fund their research for a new technology called HDTV (high density television). The technology for the picture tubes already exist, as many of you who work with super VGA monitors may attest to. The biggest problem is coming up with a broadcasting standard (which about a dozen companies are currently competing for). So why do American companies need American tax dollars to research technology that already exists and to research a standard into which other companies are putting their own money?

Digital radio, as discussed in an article in this issue, is yet another cutting edge technology. The technology could incredibly improve reception over today's best radio technology. Besides, wouldn't it be nice if the compact discs the radio stations are playing actually come across with compact disc quality sound on your radio? So where is this technology if it has got so many advantages?

My grandfather, an 85 year old man, had his own gasoline driven automobile as a young man. Today, he still drives a gasoline driven automobile. Sure, he doesn't have to crank start it anymore, and maybe it goes a little faster and hauls a bit more weight now. Underneath, however, it is still the same internal combustion engine that runs the automobile. One would think that might have changed by now, especially considering the fuel that drives the automobile contributes to the greenhouse effect, smog, and 300 square mile oil slicks off the coast of Saudi Arabia, and considering that the world's petrol sources are limited. So why do we continue our fascination with gasoline-powered transportation?

Sure we run into a few technological barriers with each of these problems, but certainly nothing that cannot be conquered by the innovation of the American mind. Our greatest problem is stagnation. We continue to watch the same televisions we have watched since the color tv, listen to the same radios we have listened to since stereo FM, and driven the same cars since, well, since Ford. Sure, each of these have their own little enhancements, but America's corporations and consumers seem to revolve around these products of days gone by. Corporations make too much money off of current products to advance to new products, and the consumer is too itchy to try something new. Can it be any wonder we are facing a recession?

If we are going to make the change to new and innovative products, we can not thrive on innovative designs alone. We have got to get our corporations and consumers to support the innovations we are capable of dreaming up. Let's not make the same mistake we made a quarter of a century ago when we practically gave to the Japanese a little-known American innovation that would soon rival all other major forms of entertainment — the VCR.

John R. Fultz

1. Using the mathematical functions: tangent, cosine
   and the numbers: 3, 5, 14, and π (3.14159 ...)
   and the operations: +, x, / (add, multiply, and divide)

   Express the fraction $\frac{1}{2}$ as some combination of the above symbols, using each one at least once. (Hint: try using angles in radians)

   This problem is worth $20.

2. The centers of three circles of radius 10 lie on the vertices of a triangle of sides 25, 35, 40. What is the area of the smallest triangle which will enclose all three circles?

   This problem is worth $20.

Due to a typo, the following problem was stated incorrectly last issue. It is still worth $25.

A marching band wants enough people to form two perfect squares in twelve different ways. What is the smallest number of members the band needs if all members are to be used every time?

see inside back cover for rules

last issue's TechTeaser solutions

Find a perfect square which is still a perfect square when you add five to it or subtract five from it. This problem was given to Leonardo Fibonacci at a math tournament by Roman Emperor Frederick II.

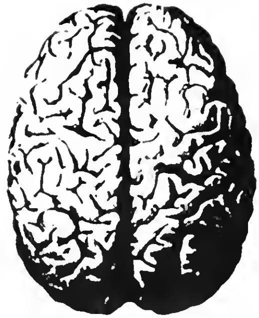
The number is $\frac{1681}{144}$ or $\left(\frac{41}{12}\right)^2$

$$\left(\frac{41}{12}\right)^2 + 5 = \left(\frac{49}{12}\right)^2$$

$$\left(\frac{41}{12}\right)^2 - 5 = \left(\frac{31}{12}\right)^2$$

We apologize to those readers who submitted imaginary numbers as answers to the problem if the question was unclear. A solution is given in G. W. Popov's Historical Problems.

Congratulations to Elsie Simpson, a graduate research assistant in nuclear engineering for submitting the correct answer.



Kara Federmeier

Dual Brains
The Flip Side of the Story

"An interest in the brain requires no justification other than a curiosity to know why we are here, what we are doing here, and where we are going." (Mac Lean).

The brain is a fascinating object. It remembers. It forgets. It analyzes. It cries. It sings. It is easy to agree with Mac Lean when he states that an interest in the brain requires only that one be interested in the basic why's, what's and where's of humanity. University of Illinois Professor Marie Banich says that her own interest in the brain is motivated in part by a desire to know herself in a different way. An interest in the brain is, in essence, an interest in answering those questions which are asked by all human beings, and the brain is, perhaps, the one object to which humans can turn to find the answers to these questions. The brain is also the object asking the questions – an irony which makes the study of the brains only that much more engaging. Even more interesting is the fact that recent science has shown that the brain can no longer be thought of as a singular organ. It is now known that there are two brains, each with its own, separate physiological make-up, area of control, and, indeed, basic "personality". To study the brain effectively requires a basic knowledge of these two hemispheres and their ways of perceiving the world. Perhaps this basic knowledge can best be gained by studying the research that led to the discovery of the separate left and right brains – split brain research.

Research in the separate hemispheres of the brain came only some ten years after the split brain was "created" surgically by mankind. In the 1940's, experimental surgery was proposed for a group of patients with epilepsy severe

enough to remain unaffected by normal chemical treatments. The proposed surgery involved a commissurotomy, a severing of the corpus callosum, the large bundle of nerves connecting the two hemispheres. It was hoped that this procedure would decrease the effects of the epilepsy by separating the two hemispheres and thus decreasing the brain mass available for seizure. The first such operation was performed in Rochester, New York, by neurosurgeon William Van Wagenen in the early 1940's. Research conducted after the surgery by Andrew Akelaitis showed little change in the patients' perceptual or motor abilities, and also, unfortunately, little change in the severity of their epilepsy. The surgeries were discontinued, and it wasn't until nearly ten years later, in the early 1950's, that the true results of this procedure were discovered.

At that time Ronald Myers and Roger Sperry were conducting research on cats which had undergone split brain surgery and which had also had their optic chiasm severed. This meant that visual information seen by each eye would reach only the one hemisphere now connected to that eye, the one opposite it. The scientists conducted their research by patching one of the cat's eyes and then teaching the cat a visual discrimination task. When the other eye was subsequently patched, it was found that the cat could not perform the task and had to be retrained for that eye. In effect, the scientists showed that they had trained the two hemispheres of the brain separately.

This discovery led scientists to reconsider commissurotomy as a means of controlling epilepsy, but this time with a more complete separation of the hemispheres. The past operations had involved only a partial separation of the corpus callosum and had left other connecting fibers untouched. This time it was felt that no nerve connections between the hemispheres should be left intact. Therefore, surgeons Phillip Vogel and Joseph Bogan performed several more split brain operations in the 1950's. This second set of operations showed a marked improvement in the patients' medical conditions, as well as no detrimental effects to the patients' behavior or abilities. Post-surgical testing by Roger Sperry and Michael Gazzaniga, however, soon showed that these operations had indeed had their effects upon the patients and upon medical science.

Testing on these patients was performed on the same basis as the experiments done earlier on the cats. The procedure was a little different, since the patients' optic chiasm was still intact. The results, however, were the same. The patients received stimuli to only one side of their brain. It was then that the discoveries really began. It was found that patients who viewed a word in their right visual field, and thus with their left brain, could correctly say what they had seen. If they viewed the same word in their left visual field, with their right brains, however, they would verbally report that they had seen nothing. At the same time though, they could pick out with their left hand, controlled by their right brain, that object which corresponded with the word they had seen, even while insisting that they did not know what the object they were holding was. This discrepancy led scientists to the discovery that the two hemispheres of the brain had distinctly different properties, and therefore led to the discovery of the dual brain.

Briefly and very generally, the left brain was found to be mathematical, detailed, sequential and analytic in its processes. It was found to control speech abilities in most people, as well as reading, writing, naming and sequential ordering. It was also found to be the language

dominant hemisphere in a majority of the test subjects, the hemisphere "in control" most of the time. The right hemisphere, on the other hand, was found to be holistic, symbolic, emotional and intuitive in its processes. It controlled spatial and musical abilities, facial recognition, and perception of abstract patterns. It was usually not language dominant, although it could be dominant for a short time when the task at hand was more suited to its abilities.

These classifications are, however, only general patterns and are the subject of much testing and debate. The right hemisphere, for example, understands and responds to the experimenter's directions to "pick up the object you saw" – and this ability can be well developed in some subjects of study. In addition, the right hemisphere seems specifically specialized for some types of language ability. Lesions in the right hemisphere cause deficiencies in spontaneous conversation, hesitancies in finding the right word, difficulties in giving definitions and paraphrases, difficulties seeing the point of humor or double entendre, and deficiencies in story-telling. The right hemisphere is certainly necessary to everyday language ability as well, because it is the hemisphere which interprets and produces body language, facial expression, and intonation – the left hemisphere responds, in general, only to what people say, not how they say it. Therefore, the right and left hemispheres develop separate but overlapping stores of knowledge, and may have different "impressions" of the same experience. Of course, degrees and types of differentiation between the people – differentiation seems in some areas, for example, to be organized somewhat differently for women than for men. The tendency for hemispheric differentiation, however, is present from the moment of birth – newborn babies show a much stronger EEG response from their left hemispheres after speech sounds, while non-speech sounds give the opposite effect. The duality of the brain, though not well understood, is

obviously an intrinsic feature of the organ.

Pieces to the puzzle of hemispheric differentiation are being put into place all around the world, and the University of Illinois contributes to this process. For example, Professor Banich and her graduate student Aysenil Belger have conducted research on how hemispheric differentiation is useful to human thought processing. By asking subjects to answer questions about visual stimuli (for example, "Are these two letters/digits the same?"), they have studied how hemispheric differentiation helps or hinders the solving of the tasks. In some cases, all of the critical stimuli needed to make the decision are presented initially to either one hemisphere or the other by having subjects focus their eyes on a center point while the stimulus is flashed in their right or left viewing area. In other cases, the stimulus is divided in the viewing field and is presented to both hemispheres simultaneously. The results of these studies have suggested that simple tasks are solved more easily by the use of only one hemisphere, while more difficult tasks require the cooperation of both hemispheres. Hemispheric differentiation, therefore, could help humans solve difficult problems by allowing them to benefit from both the kinds of reasoning available in the left and right brains respectively.

Much research is still being done on the two hemispheres of the brain, how they interact, and what they each control, but the basic duality of the brain can no longer be denied. Split brain research has shown beyond a doubt that although the two hemispheres of the brain may look alike, they are, at the heart of things, very different. Nature has provided humanity with not one miraculous brain, but two. Two brains, and two reasons to be interested in them. Perhaps Mac Lean would have been more correct in proclaiming no need for justification of interest in our brains other than a healthy curiousity to know why we are here, what we are doing here, where we are going, and why it takes two of us to figure it all out!

TECH VISIONS

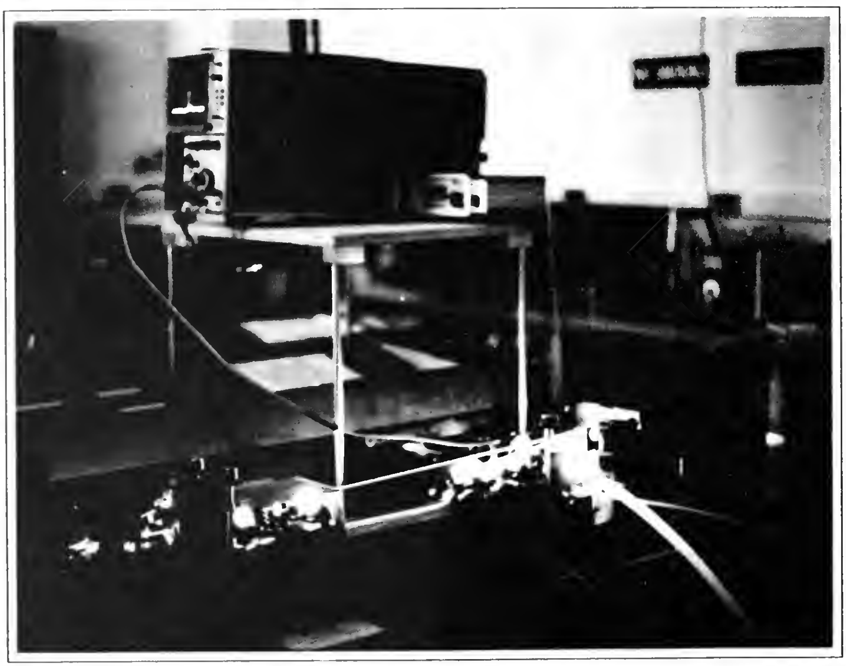
Physics 100th Year

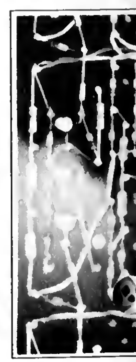
at University of Illinois

Celebrating 100 years of Physics at University of Illinois, past &present

The laser (1 and 2) is a tunable Neodymium-YAG laser used in the Laboratory for Fluorescence Dynamics to study proteins. The lab is one of only three of its kind in the country and is run by Martin vandeVen (3).

Also shown are various laboratory "antiques." This circuit board (4) was part of a larger board used in a computer. It was eventually replaced with the transistor. The betatron (5) shown is also an older model. The cloud chamber (6) will detect the presence of cosmic rays and show them as a string-like interruption in the cloud. An old gyroscope (7) also stands among Loomis' antique collection.





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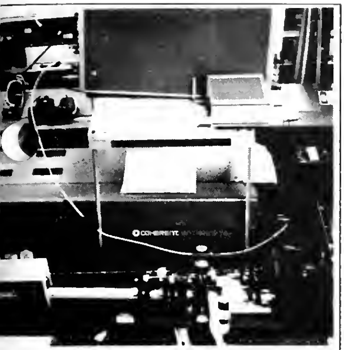

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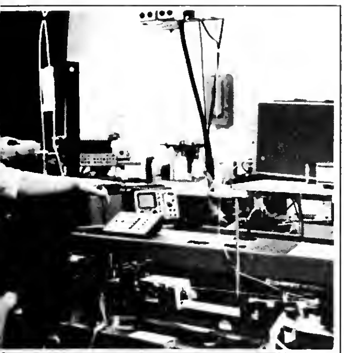

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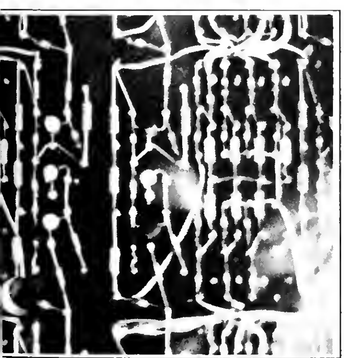

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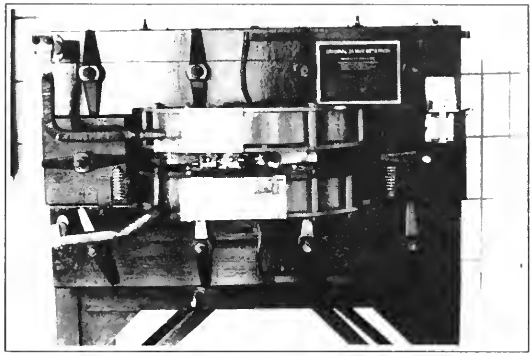

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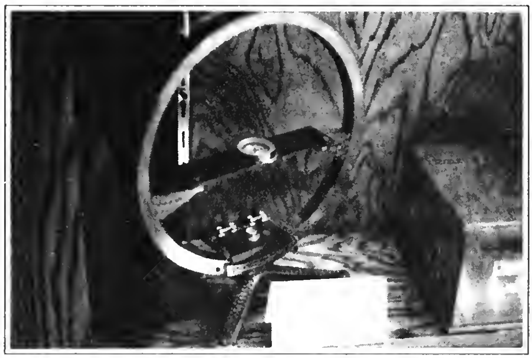

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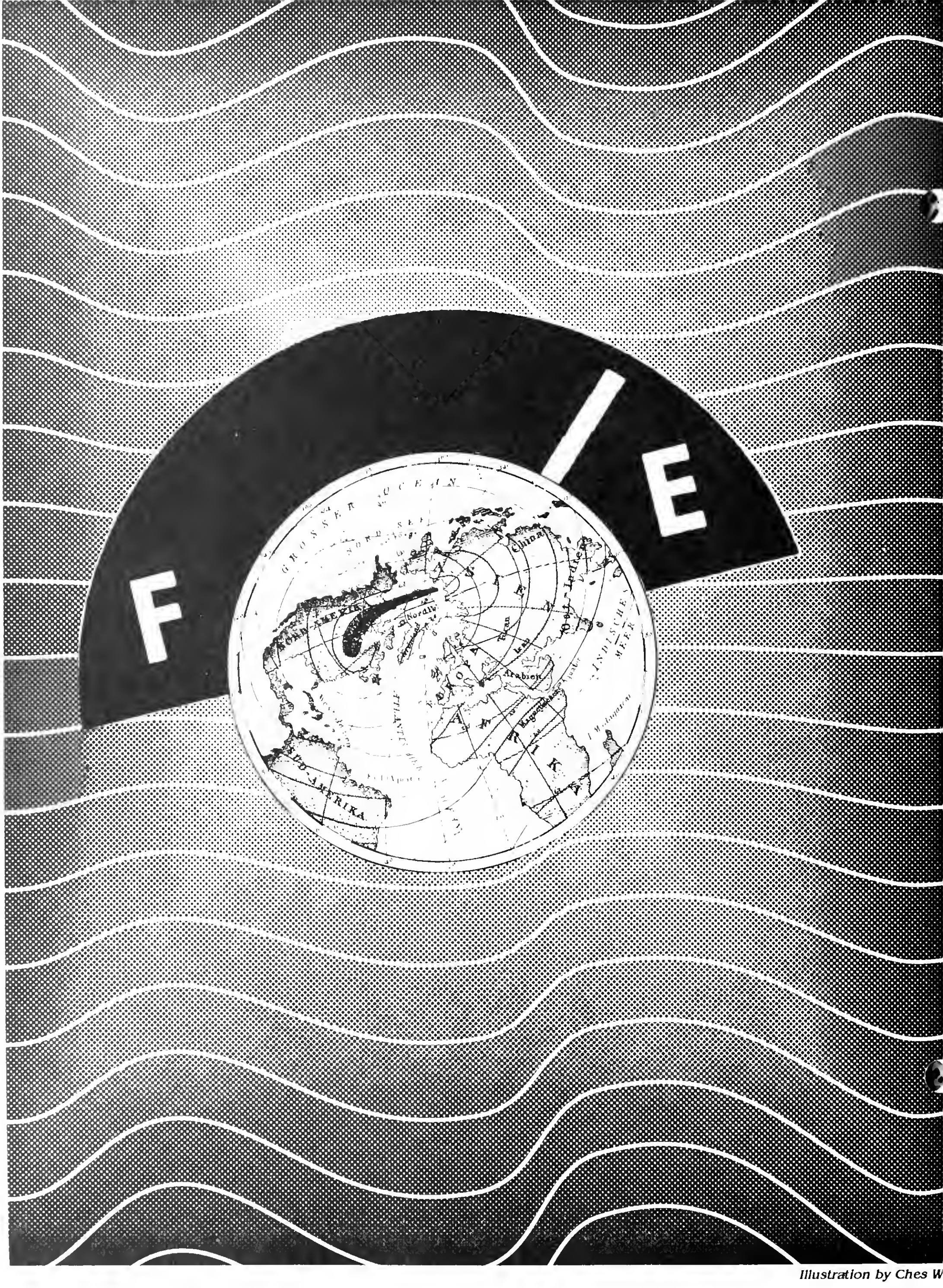


Illustration by Ches W

America's Infatuation with Oil

Joshua Birk

As man progresses, as he evolves, as his society grows more expansive and complex, his need for technology grows. American society is engrossed with tools and toys of the modern age. Life in the twentieth century is made fast and easy, and as technology advances, it is made faster and easier.

The stagnation of this process, especially if centralized in a particular area, can have devastating effects upon society. If the population grows without the advanced technology, then the use of the outdated technology becomes embedded as a part of society. This old technology may be harmful, particularly if used frequently.

Transportation is an incredibly dangerous center for stagnation. The area of effect for transportation is global. Man currently travels farther and is more dependent upon his cars and planes to live on a daily basis than ever before. Transportation has been stagnated, however, since about the turn of the century. Around the 1900's, gasoline powered automobiles began to appear. They edged out their opponents, the electric carriages, in a race of distance. America was beginning a vast countryside, and people wanted to wander. They did not want to be weighed down by two-ton Edison nickel-iron batteries. They wanted to be able to strap on a few more tanks and be able to go that much farther.

Today, transportation and the automobile industry in particular, has not changed, but it has grown. Our cars are bigger, faster, stronger, and consume more gas. The other transportation industries, including airlines, trains, and public transports, are almost completely fueled with petroleum and its by-products.

This connection to oil and society's need for the transportation market makes oil an extremely powerful commodity. Oil prices can have drastic effects on a society. A raise in the price of oil means a raise in the amount a consumer pays for gas. A consumer who pays more for gas has less money to spend on products. A manufacturer then has less money with which to produce and must spend more on transporting his goods. The process continues in a vicious cycle, and both consumer and manufacturer are left at the mercy of oil prices. The entire cycle of trade can lead to economic recession, according to many economists.

The influence of oil can also be political, and oil has been partly responsible for our recent involvement in the harshest form of politics, war. Of course, this does not mean that the American government is solely concerned with the price at which Americans buy oil (think gas tax). However, the Middle East draws most of its influence from the oil market, and America certainly could have higher stakes in that portion of the world. Probably one of our government's greater fears in the Middle East is that of a coalition united against American involvement in that area.

In the long run, however, nothing will have changed. Whether or not the war ends in a matter of weeks or years, though, Americans will still be pumping gasoline at the corner gas station, and therein lies the problem because the stagnation has been continued.

The only true answer is to advance our own technology past the necessity of oil. Major technological revolutions have often been heralded by the bringing of a new power source. When wood gave way to coal, the Industrial Revolution began to thrive. Gasoline introduced a powerful and seemingly expendable fuel. Mass transport was born. It will shortly be expended, as estimates show that world-wide resources will be gone in four decades, around the year 2030.

With sweat and perseverance, four

decades is enough to bring about the next energy supply. Some of the technology exists, but it still remains to be implemented in our tools and toys. Hydrogen as a base for fuel is one available option. It can be made to be used in internal combustion engines, and it burns more powerfully and efficiently than gasoline. It also does not create yet another pollution problem. Considering the Earth's vast oceans, hydrogen supplies should last millions of years.

What remains to be changed is society. A new energy supply would completely rewrite the script of contemporary human society. Our civilization is filled with services and devices to use gasoline. Society has a foundation of close to a century's worth of old technology. All of that must be changed and advanced.

The future power source will need to conform to certain requirements to survive. It needs to be more than just accessible; a nearly limitless power supply will not convince the American mind. It will need to be powerful, possibly more powerful than gasoline. Society must find the source appealing before it considers it. It will need to be economic. Unless the new technology can revitalize a recession, the consumer may not have much money to spend on the new power source. It will need to be environmental. The generation that will begin the use of the power supply is already in a state of environmental awareness. Heavy protest could swiftly slay an innovative design. Most importantly, the source must be compatible enough with current standards to allow for a swift and easy change.

If action is taken immediately and intelligently, gradual change could subside cultural shock. Society will need to be rebuilt from the edges to the center, starting with the fringes of transportation and moving to the most concentrated forms. Alteration could begin at the federal level, changing public and governmental transportation. Commercial vehicles could then be changed. All this time, man's society would be advancing around him. When he was the only part of society left, then he would feel the need for change.

Change of any king, either subtle or abrupt, will call upon the average citizen to make necessary changes. Among the upper economic classes of society, it will mean a new purchase of technology. Depending on the fashion of the energy source, it could range from sending an old car in for modifications to buying a new automobile which runs on the new power source. Unless the new power supply is provided in an inexpensive manner, not likely for American manufacturers on a new and valuable product, the change may have to wait for those who can not afford it. This means that they will still depend on gasoline, another reason for advances to occur before the draining of supplies.

It is difficult to accurately predict the future without a new fuel source. With the draining of oil reserves, man would have no cushion to use while implementing new technology. Without the gasoline-powered devices to do so, man might find himself regressing technologically. Easier forms of fuel, possibly steam or coal, would have to provide a foundation until they ran out.

Man's greatest asset is his intelligence. It is with his tools that he has climbed up the evolutionary ladder. The makers of these tools bear power and responsibility, for they are a means by which society can be created or destroyed. Man has allowed his technology to pile up and grow stale. Its stench has polluted our air and our water. We have built and burnt an illuminating fire, or perhaps a pyre. The time to change is upon us now, not in four decades when it will be too late.

Thomas E. Glenn

From The Dean's Chair

CHOOSING AN ENGINEERING MAJOR

Are you firmly committed to the engineering major you are in? Approximately 28% of the students who enter the College of Engineering as freshmen will change engineering majors. Another 4% will change engineering majors twice.

Students can best obtain information about possible career fields by talking to people currently working in those fields and by reading magazine articles. There are a vast number of opportunities for a young student to get this information here on the University of Illinois campus. However, it does require that the student be aggressive and active in pursuing this information.

The primary source for information about career fields, companies hiring engineers and the future outlook in particular industries is available in the Engineering Placement Office located in 206 Engineering Hall. Although the Placement Office is primarily visited by graduating students, the resources in the Placement Office are available to all students, freshmen through doctoral candidates. For young students trying to decide on engineering fields, the reference room located in the northwest corner of the Placement Office complex should be your first stop. In the reference room, there are shelves filled with hundreds of reports provided by companies who often recruit and hire graduates of the college. In these reports, companies will list the engineering majors they hire, define particular job functions and describe the business activities of their company.

In addition to company reports, the Engineering Placement Office has a large collection of video tapes provided by companies. Students are welcome to view these tapes which provide valuable information about each of the companies. Also, the Engineering Placement Office reference room maintains a large collection of business magazines and newspapers for students to examine.

There are a number of national magazines published for engineering students. Several times throughout the semester, a large supply of these magazines are sent to the college and distributed through the Engineering Placement Office. Magazines which have recently been available are Women Engineer, Career Futures, Field Guide to Computer Careers, Graduating Engineer, Engineering Horizon, Careers and the Engineer, and Computer World. These magazines have articles written about engineers and their jobs, companies that hire engineers and future demands for engineers in various fields.

Another very valuable source of information provided through the Engineering Placement Office are the evening information meetings held throughout the recruiting season. Dean Mosborg and his staff schedule a number of meetings for company representatives to talk to students about various career opportunities such as technical sales, marketing, design, research and development. These meetings provide a perfect opportunity for young students to hear from people who are actually working in industries and from companies with whom they may seek future employment.

Activities hosted by the engineering student societies in the college are often overlooked as sources of career information. There are over 40 student societies within the college representing every engineering field offered on this campus. Many of these student organizations represent national professional engineering organizations which offer student memberships. Normally the membership fee for a student is less than $25 a year and includes a subscription to the national magazine. These magazines are an excellent source of information as to what practicing engineers in these fields are doing in industry.

Engineering student societies often hold monthly meetings, open to any student on the campus, with speakers from industry. Announcements about society meetings are often found in the Daily Illini, the North of Green, signs posted in engineering buildings and departmental student newsletters distributed throughout the hallways of engineering buildings.

Another excellent method for students to learn about a particular industry, company, or engineering major is to participate in the Co-op Program. A Co-op student alternates semesters between working for a company and attending school. In addition to earning money to help pay for school, the Co-op experience can help a student make an informed decision as to the engineering major they want to pursue. Students interested in the possibilities of a Co-op position should contact Dean Donnell Hunt in 213 Engineering Hall who is the Director of the college Co-op program.

Just a few of the sources available for finding out more about engineering fields have been mentioned. There are many more opportunities on this campus to visit with individuals representing companies who hire engineers. An often misunderstood point by students is that your job search really begins as a freshman and not as a senior. Throughout your entire college education, you should be taking advantage of every opportunity you can to talk to engineers in the field that you have chosen, to look at other fields if you are undecided and to start to compile a list of companies that you would be interested in working for once you have graduated. Challenge yourself to be knowledgeable and informed in planning your professional career.

Thomas E. Glenn is an Assistant to the Dean of the College of Engineering

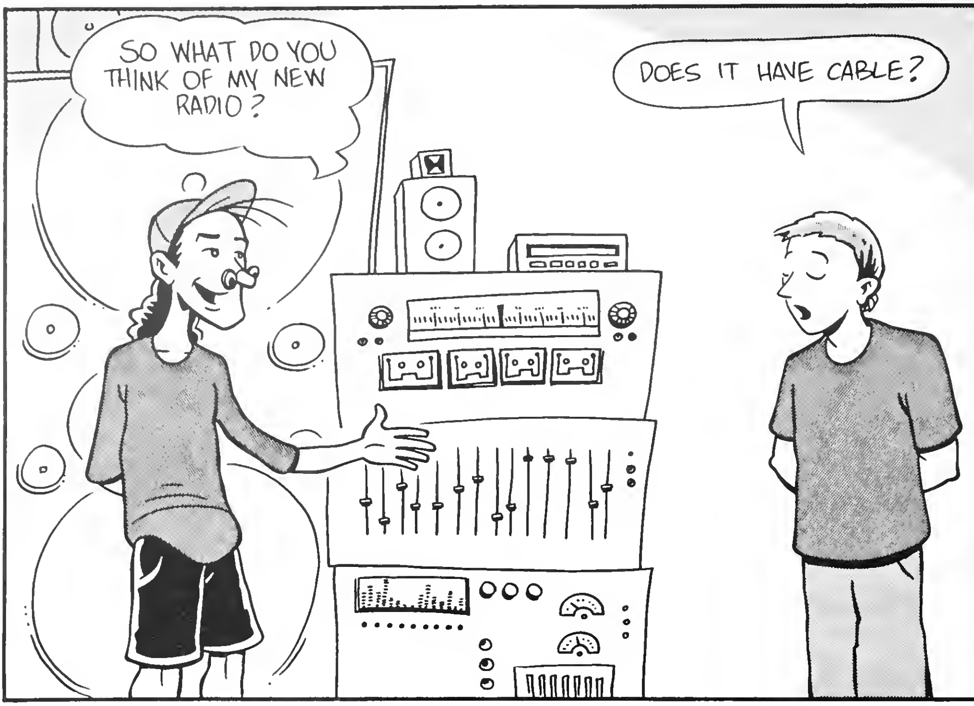


Illustration by Ches Wajda

IMPROVED RADIOS

Digitizing Analog Dialogue

Have you ever experienced the frustration of tuning in to a decent radio station only to find that the reception is terrible (except when you stand next to the radio)? Or are you annoyed to hear that it is "Hammertime" in the background static? Few will argue that radio often offers poor sound quality compared with compact discs or even cassettes.

Today's radios are analog devices. This means that the signal is transformed directly into output. An example of an analog device is a phonograph. The grooves in the record cause the needle to oscillate exactly as the grooves do, and the oscillations of the needle are transmitted directly to sound. The output is completely continuous, but problems like dirt and scratches may often arise. A compact disc player, on the other hand, is an example of a digital device. When CDs are recorded, music is sampled at discrete time intervals. The samplings are converted into numbers. If these numbers were to be graphed, they would create an approximation of the waveform stored on the record. These numbers are then converted to binary and stored onto the CD player. The CD player reverses this process. With a high sampling rate, this process results in close to error-free transmission.

What is the benefit of transmitting digital signals over the airwaves as opposed to analog? All radios up until now have been analog, and a radio made today works in essentially the same way as one made fifty years ago. (Radios have been analog ever since they were first invented.) When you hear an announcer's voice on the radio, the voice is converted into electromagnetic energy by microphone and transmitted as electromagnetic waves from an

antenna to your radio. The radio waves then excite the circuity in the receiver which causes a speaker to convert the signal back into the announcer's voice.

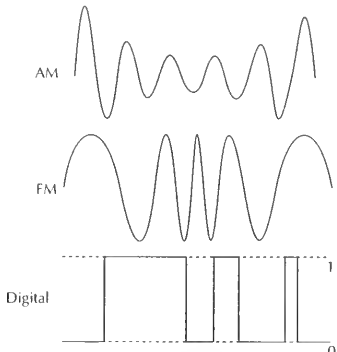
At every stage from the announcer's vocal chords to your ear, there could be signal distortions, or noise, which is what is added to the signal between its source and its destination. Radio waves are, of course, subject to reflection, refraction, and other wave phenomena. A signal that is reflected off an object might have a slightly longer path than direct signals. The reflected signal arrives slightly out of sync with the direct signals, and the result is what is known as multi-path distortion. The original sound can also be degraded by your radio, by equipment at the radio station, or by atmospheric conditions. How much noise a stereo system produces is a familiar measure of its quality.

There is nothing magical about digital that makes noise disappear, but the way the digital receiver interprets the signal minimizes the effects of noise. In other words, the noise is still there, but you cannot hear the vast majority of it. This is because the digital radio signal is comprised of what the digital receiver interprets as "ones" and "zeros." The analog signals that we use today, however, are transformed by the analog receivers directly into what we hear. A radio might possess circuitry that filters out some noise, but it is at the expense of sound quality. The filters usually lower frequency response at high frequencies, and since it does not "know" what the output should be, it can filter out some of the desired sound as well.

In contrast, all a digital radio receiver has to do to be able to produce CD quality sound is to be able to recognize the ones and zeros. This does not demand very much precision, so as long as the signal is not incredibly distorted, the radio should interpret the same exact signal that left the radio station. That in itself is a big advantage to analog radio.

The same things that make CDs better than analog recordings also apply to digital radio. The good sound quality of a CD comes in part from an error-correction system encoded in the CD. This code tells the CD player what the output should at least be similar to. If there is noise in the recording, the CD player will recognize it and filter some of it out. These same signals can be encoded in digital radio.

Fitting digital radio stations on the radio dial is a problem. The spectrum is already filled with channels for a variety of uses. Digital channels require a large bandwidth, which simply will not fit on the



different types of radio signals

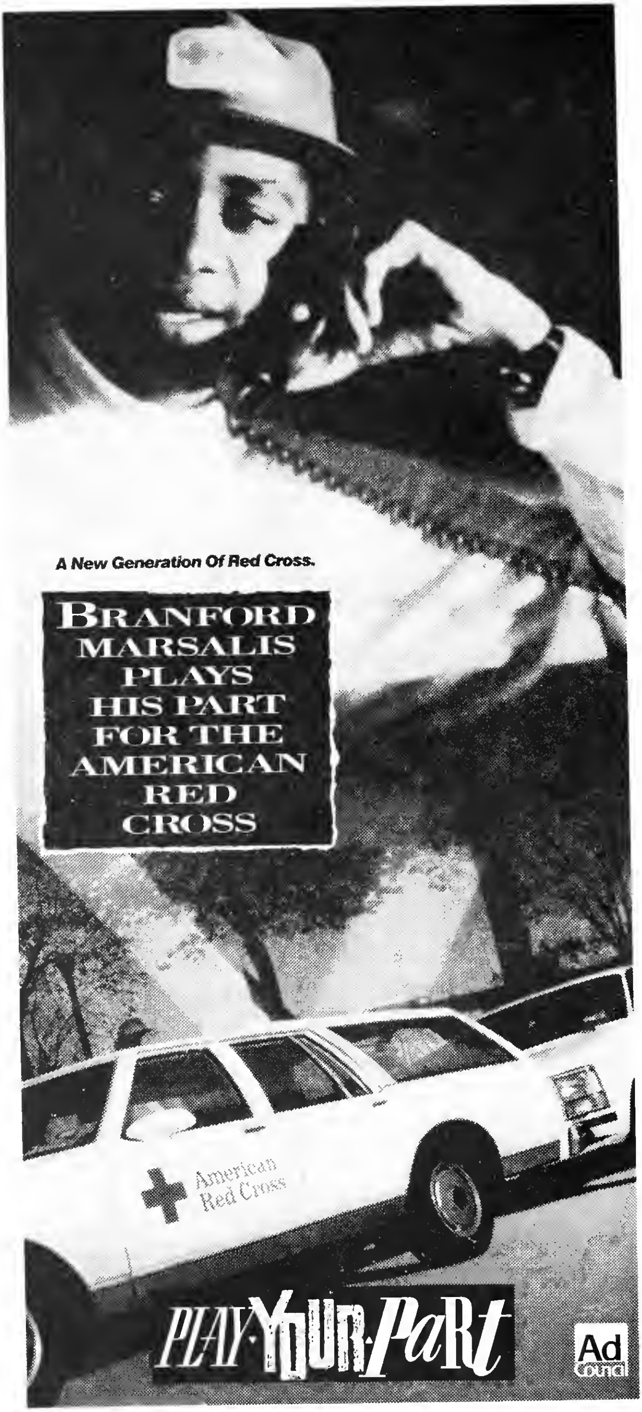
maximum allowable bandwidth for FM radio. CDs sample at about 44 kiloHertz — each second is divided into 44,000 instants at which the sound intensity is sampled. Since each of those instants is represented by a 16 bit number, the number of bits that need to be transmitted each second is on the order of one million. For a faster flow of data, a greater bandwidth is needed.

Another obstacle in making digital radio a reality is that implementing it would render existing radios obsolete. A digital radio station would sound like gibberish on a conventional analog radio. Thus, enterprises in digital radio would have to rely on consumers buying the receivers that can decode the digital signal.

There are already some proposals for digital radio systems. some involve not sending the signals over the air waves, but through the cable that supplies cable television. For fixed stereo systems, cable audio is ideal. However, you will never see joggers plugged into their walkmans with long cables trailing them. Additionally, a large part of radio audiences listen from their cars, which also can not be reached by cable. while cable would be a good system, it would limit the audience.

Several companies are working on radio systems which allow for CD-quality channels, but also for lower quality channels as well. Some types of programming, like talk shows, do not require perfect sound reproduction. The incredible stream of information can be compressed. Some information may be destroyed, but as long as the output is clear and intelligible, it is worth reducing the necessary information. In the November 1990 issue of **Popular Science**, Mark Fleischmann writes that a company called Satellite CD Radio will launch two satellites to carry digital radio signals that can be received nationwide. Sixty-six channels of CD-quality audio would be available from this system. Another company, Radio Satellite Corp., is planning to broadcast both CD-quality and lower quality channels via satellite by 1993. This only scratches the surface of companies developing digital radio systems, with a lot of research being done abroad. Keep your ear out for digital radio. You'll hear a lot more about it in the decade ahead.

Mark Maslov


A New Generation Of Red Cross.
BRANFORD MARSALIS PLAYS HIS PART FOR THE AMERICAN RED CROSS
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Ad Council

Tech Teasers Contest

Rules: The problems on page 3 of this issue could win you money! All you have to do is mail your answer(s) for either problem, name, address, and phone number to the following address:

Tech Teasers Contest
Illinois Technograph
Illini Media Company
57 E. Green St.
Champaign, IL 61801

The first person to submit a correct answer for each problem will win the amount specified for each problem. In case of a tie, a name will be drawn to determine the winner. This contest is not open to employees of Illini Media Company.

ILLINOIS TECHNOGRAPH

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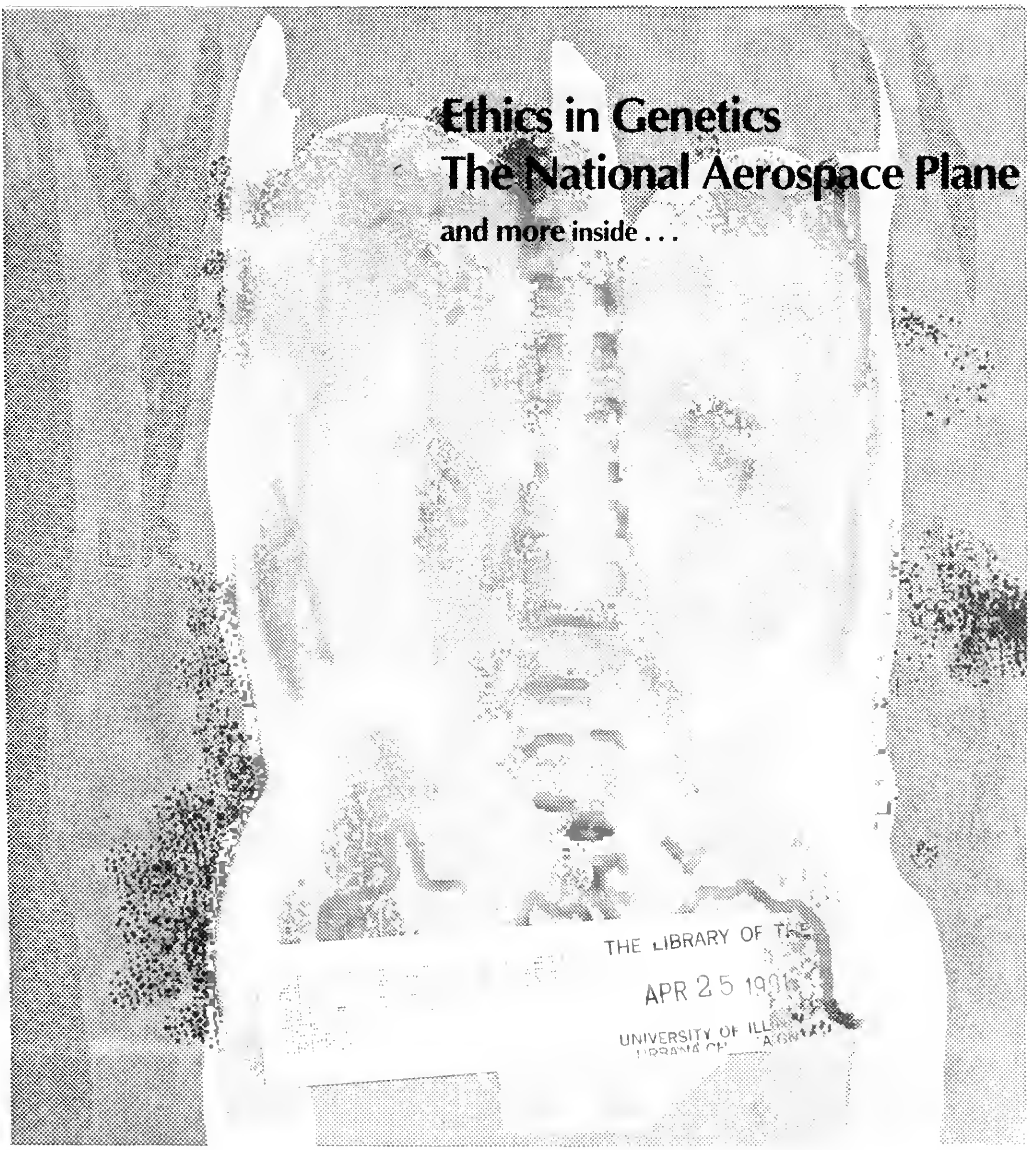
Ethics in Genetics
The National Aerospace Plane
and more inside . . .



Do you have any writing skill? *If so, we can use your talent. The Technograph always has positions open for regular writers. The Technograph also accepts freelance submissions for people who only have the time for a single submission. We accept articles on most engineering and science related topics, and we encourage engineering graduate students to write about the projects they are conducting. For more information, contact John Fultz at 332-4071, or Chi-Ting Huang at 328-6808. You may also leave a message at Illini Media, 333-3733.*

ILLINOIS
TECHNOGRAPH

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Illinois Technograph
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Illinois Technograph (USPS 258 760)
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editor's remarks

John Fultz

Some of us just don't relish the good old days. We sometimes tend to remember the blunders of our time instead of remembering our true accomplishments. Here at the Technograph, however, we rather relish some of our past days.

The Technograph was a tradition of excellence. Soon to celebrate its 106th birthday, the Illinois Technograph was the one of the oldest and best established college engineering magazines around. Combined with the reputation behind the College of Engineering, the Technograph had no problem attracting a great pool of advertisers and good technical writers. A part of the Engineering College Magazines Associated, the Technograph was also an award winning magazine.

Due to a variety of reasons, and with no one in particular to blame, the Technograph waned over the past several years. In fact, only a couple of years ago, the magazine was struggling for its very survival. My arrival, and the arrivals of the two editors before me, were rather fortuitous, as there was no one else to take the reigns during those years.

These are the plain facts. However, the Technograph is back on the road to recovery. With a strong design and photography staff and the resources provided by our owners, Illini Media Co., we have struggled for a professional, yet pleasing, look to the magazine despite the limited budget. The College of Engineering has pledged its support for the resources it can provide.

This is not quite enough, however. To succeed, we need the help of the student body . . . you. The magazine has need of resources that only the student body can provide. There is so much that we can provide each other. Articles or other work published in the magazine are seen by nearly every prominent engineering college in the United States, as well as in nearly every high school in Illinois. Decent freelance work on science and engineering topics always has been and always will be considered for publication. The Technograph pays any student whose articles or other works are to be published. Articles need not, and should not, be highly technical in nature, as the magazine should appeal to anybody who possesses interest and a limited educational background in engineering. Finally, employers like students who can prove that they can communicate clearly and/or lead others efficiently.

I don't think I'm begging or that I need to beg, folks. The Technograph is a great experience, and I'd love to have many people share in it. So let's see if we can forget these "good old days", and move ourselves into the future.

John R. Fultz

For more information about the Technograph, call 333-3733 and leave your name and number, or write:
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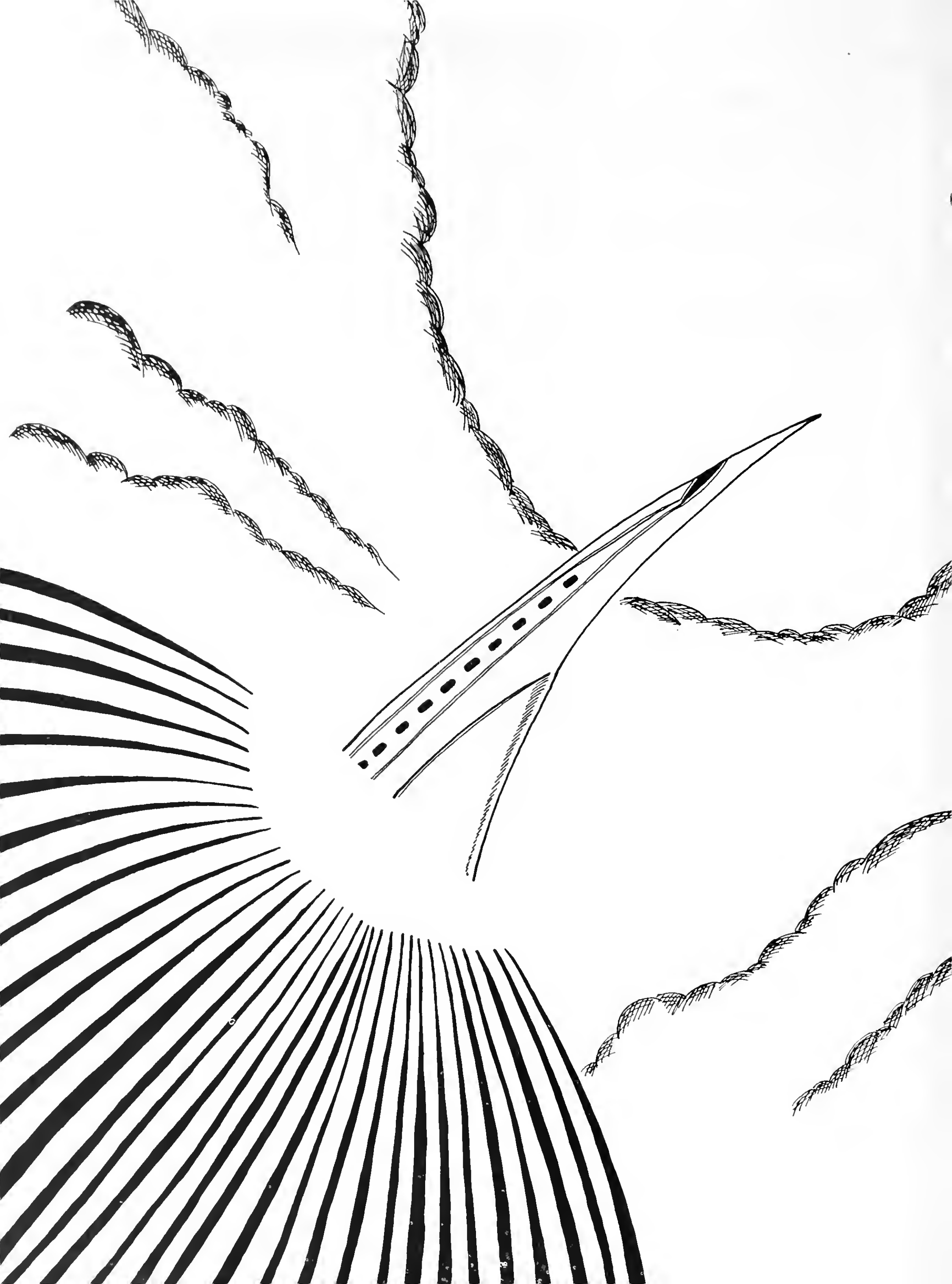
1 Joe college student is failing Professor Bob's class badly. Since Professor Bob is really a nice person at heart, he decides to give Joe a second chance. Professor Bob says, "Joe, I have two sons. The differences of the cube of their ages is a square and the difference of the square of their ages is a cube. Find their ages for me and I will consider passing you in this class." Help Joe find the answer to pass the class.

2 Joe's girlfriend Muffy is also failing Professor Bob's class. Since Professor Bob gave Joe a chance to pass the class, he must also give the same chance to Muffy. Professor Bob says, "Muffy, the number 32,547,891 multiplied by 6 (thereby using all nine digits once and only once) yields 195,287,346 (a number also containing all nine digits. I may pass you in this course if you can find another number to be multiplied by 6 to satisfy the same conditions." Joe will be very depressed if Muffy does not also pass this course; help Muffy find the answer she needs to pass Professor Bob's course.

3 A simple way to shuffle cards is to take the pack face downwards in the left hand and transfer them one by one to the right hand putting the second on top of the first, the third under, the fourth above, etc. until all of the cards are transferred. If you do this with any even number of cards and keep repeating the shuffle in the same way, the cards will eventually return to their original order. How many shuffles are necessary to return a deck of cards (52 cards) to their original order?

4 Four college students, Brian, Liz, Eric and Sheila enter a square field simultaneously at the NE, SE, SW, and NW corners respectively. All the students run at the same speed. Brian has a crush on Liz and chases her. Liz is rather fond of Eric and chases him. Eric admires Sheila and chases her. Sheila finds Brian to be quite interesting and chases him. These college students are not very bright and each always runs directly toward the person they are chasing making no attempt to head their quarry off. Obviously, the students will eventually spiral into the center of the field. If the sides of the field are 200 yards, how far will each person have to run before they all collide in the center?

Thank you for your support of this year's Tech Teasers Contests. Since this is the last issue of the academic year, the tech teasers here are strictly for fun. Look for the return of the contest next year! Answers are on pages 19 & 20.



Ken Smith

National Aerospace Plane

Converting Theories to Reality

The United States program to develop a hypersonic National Aerospace Plane (NASP) is one of the most technologically challenging endeavors the aerospace industry will face in the coming decade. Reaching speeds of 25 times the speed of sound, the NASP is an unprecedented effort to integrate several advanced technologies into a manned vehicle: propulsion, materials, aerothermodynamics, and controls. The NASP is especially attractive because it will be able to takeoff from conventional runways eliminating the need for expensive launch facilities. If successfully deployed, the NASP would accomplish full reusability, demonstrate single-stage-to-orbit (SSTO) capability, and open the space frontier to routine operations.

Previous aerospace development programs have been heavily dependent upon wind tunnel testing to offer design direction and to validate design decisions. Unfortunately, no wind tunnel facility exist today, or in the near future, that can reproduce the flight conditions of the NASP. Consequently, the NASP design is dependent upon an emerging field of fluid mechanics, Computational Fluid Dynamics (CFD). CFD researchers face the formidable task of creating computer codes that can accurately predicting the complex flowfields the NASP will encounter during Mach 25 flight.

Historical perspective

Initial investigations into the development of a SSTO hypersonic vehicle utilizing air-breathing propulsion began in the early 1960's, but were hampered by insufficient computational capacity. Performance evaluations for hypersonic designs were limited to idealized geometries for which empirical data were available. Although this approach yielded estimates of total vehicle forces, the details of the vehicle's flowfield could not be calculated. A thorough knowledge of the vehicle's flowfield is crucial to designing the NASP's air-breathing engines.

From 1970 through the mid-1980's, advancements in computer resources provided researchers with the tools to develop fundamental hypersonic fluid dynamic algorithms applicable to NASP. The recent explosion in computer speed and memory storage has permitted the incorporation of this early fundamental work into more comprehensive codes.

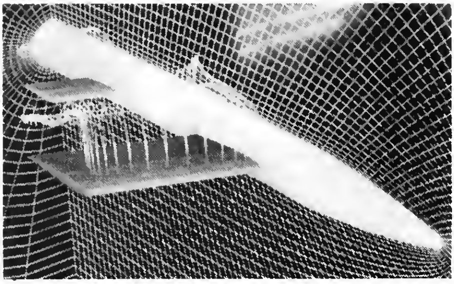
CFD challenges of the NASP

The solution of fluid dynamics problems are often difficult due to the mathematic complexities involved in simultaneously satisfying all the conservation equations: mass, momentum, energy, and species. Usually the governing equations can be simplified considerably by neglecting insignificant terms. But even in limiting forms, few analytical solutions exist, and then only for theoretical studies that are difficult to apply to practical engineering designs. Computational Fluid Dynamics (CFD) extends the study of fluid mechanics by developing computer codes to satisfy the governing equations. CFD codes for the NASP project are especially challenging due to the physical complexities of hypersonic flight: shock waves, chemical reactions, turbulence, and rarified flow.

When an aerospace vehicle exceeds the speed of sound, a supersonic shock wave forms so that the fluid can rapidly negotiate its way around the vehicle. One example of a shock wave is the sonic boom heard when the Space Shuttle re-enters the atmosphere. Shocks can be thought of as very thin regions in the flow where abrupt changes in the fluid proper-

ties (temperature, pressure, etc.) occur. These shocks can be difficult to "capture" within CFD simulations.

At five times the speed of sound or more, hypersonic shocks will be created that radically alter the flow's properties — even the chemistry. For example, immediately downstream of a hypersonic shock, temperatures can exceed 6000 K — sufficiently high to invalidate the ideal gas assumptions. Also, these temperatures encourage the flowfield to chemically react. The energy changes involved with these chemical reactions influence the resulting flowfield and must be included in the CFD analysis.


This graphic, designed in part by Ken Smith, illustrates a theoretical flow field for the Mach 25 spaceplane.

The flowfield over a vehicle is often described by fluid dynamicists as being laminar or turbulent. Laminar flows are stable and can be calculated in a straightforward manner using well-established equations. Turbulent flows are highly unstable and exhibit chaotic behavior. At present, no comprehensive understanding of turbulence exists; therefore, CFD researchers must use complex models to predict the motion of turbulent flows. Turbulent flow modelling is important to NASP designers because of two detrimental characteristics of turbulent flows: increased heat loading on the the vehicle, and increased aerodynamic drag. The design of adequate thermal protection and propulsion systems is dependent on the ability to model the laminar and turbulent flows over the NASP.

Finally, at normal pressures and densities, fluid flows are often treated as being a continuum. The continuum assumption asserts that the fluid molecules are very close together and that a great many molecules are present in any given volume. However, at flight altitudes of 80 kilometers or more, the flow can no longer be considered a continuum, since the NASP will encounter conditions where the atmospheric density is very low and the mean free path between the gas molecules becomes relatively large. These conditions are referred to as the rarified regime and offer distinct CFD challenges because now individual molecules are important. New constitutive relationships for rarified molecular transport processes are now being developed that can better utilize present computational facilities.

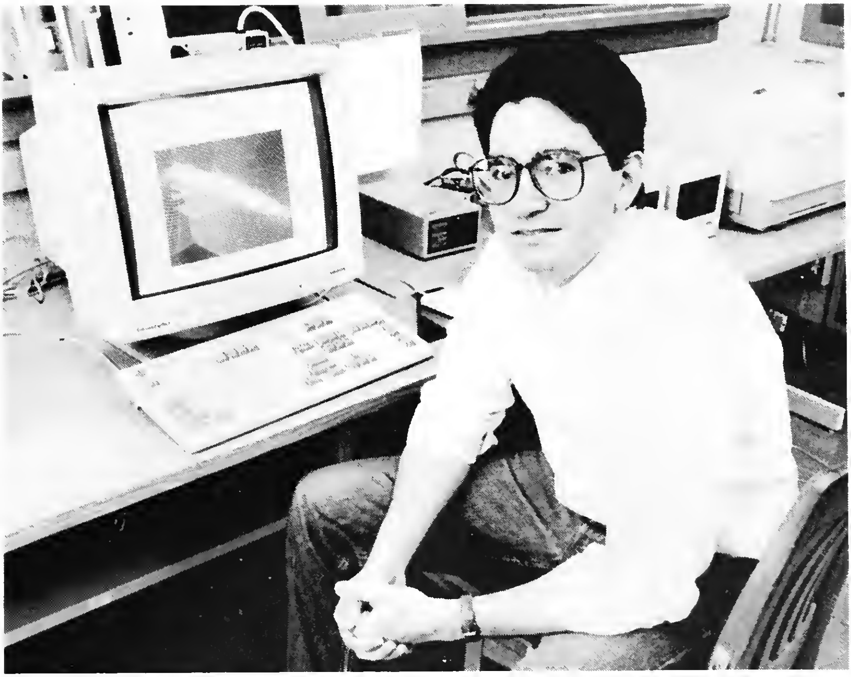
CFD progress

Initial hypersonic CFD results are encouraging. Recently, a three-dimensional solution demonstrated excellent results for a Mach 15 wind tunnel experiment; a comparison that emphasized the importance of simulating the complete tunnel flowfield. Also, a successful unsteady code compared favorably with empirical results for a two-dimensional unsteady supersonic flow. Good agreement between experimental results and computer solutions is crucial to gaining confidence in the CFD simulations.

Research into analyzing the complete vehicle has resulted in a new simulation approach utilizing the concept of a zonal-solution methodology. This supercomputer based concept involves generating a three-dimensional numerical patchwork mesh over the vehicle. The individual patches are then solved simultaneously using CFD codes specific to the flow conditions anticipated within that patch (e.g. boundary layers, inviscid freestream, unsteady, chemical kinetics, etc.). The resulting solution would be much faster and more manageable than a general all-inclusive code.

As aerospace computation models continue to develop, efficient interpretation of the CFD simulation will require advanced graphical visualization techniques. Visualization research being conducted at NASA is concentrated on using high performance graphics workstations to view, and in some cases, to animate these simulations. Connected to a supercomputer via a high-speed channel, these workstations post-process the CFD results into comprehensible three-dimensional images. Future efforts will develop interactive tracking and steering of the supercomputer solution. Tracking allows the scientist to view his/her solution so it can be stopped and restarted at will. Steering goes one step further and allows the scientist to change the parameters of the flow solver as it executes. Examples of steering include increasing the angle of attack during a pull-up and performing a flight maneuver.

The success of the United States National Aerospace Plane (NASP) program is heavily dependent on Computational Fluid Dynamics (CFD) to provide flight predictions at Mach 25 speeds. Assuming continued federal funding and research achievements, the NASP is destined to take a place in history as a tremendous technological achievement for the United States.



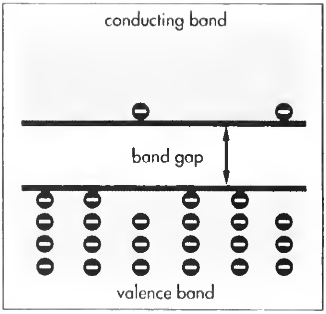
Ken Smith displays the equipment which he used to help him design the NASP flowfields.

EXCITONS IN SEMICONDUCTORS

JOHN W. SHIROKOFF

Created by photoexcited electrons and positively charged "holes" in semiconductors, excitons play a crucial role in the optical properties of semiconductors.

It has long been known from experiment and conventional wisdom that the naked eye cannot physically see electrons in nature but rather just the light given off when they change from one atomic orbital to another. As a consequence we use scientific models to describe the motion of electrons in solid matter. The interaction of light with electrons in solids is of fundamental importance to modern physics, based on the quantum mechanics of many atom systems. In a practical sense, understanding electronic motion is essential to improving the quality of opto-electronic devices and integrated circuits. Experiments involving photon-semiconductor interactions also contribute to the characterization of defects in elemental and compound semiconductor materials.



Typical pure semiconductor: two electron-hole pairs are shown (fig. 1)

First, what are "excitons" and how are they created by light in a crystal? To unravel the inner workings of semiconductor crystals, one must look at the crystal lattice in terms of its electron energy levels. Essentially, electrons in a crystal are distributed among "energy bands" in such a way as to characterize it as metallic, semiconducting, or insulating. In semiconductors at low temperatures the energy bands are either completely empty or full of electrons, and the highest filled energy band is called the "valence band". Also present is a "conduction band", which is normally empty at low temperatures, and is separated from the valence band by an energy referred to as the "band gap". Under these conditions there is little chance of electrical conductivity in a pure semiconductor. However, when some valence electrons are thermally excited up to the conduction band there can be a measurable electrical conductivity. (see fig. 1)

The absorption of a photon by a semiconductor crystal can likewise move an electron from the valence band to the conduction band. This process also leaves an empty state behind in the valence band referred to as a "hole". Once created, the electron in the conduction band and the hole in the valence band, known as an electron-hole pair, can further reduce their total energy by binding together to form an exciton. The exciton binding energy is typically quite low and the weak excitonic bond can easily be broken by thermal vibrations of the crystal even at room temperature. So in order to produce significant numbers of excitons in a semiconductor crystal, the solid must be cooled a few tens of Kelvin.

How can excitons be detected in a semiconductor crystal? Excitonic energy levels can be determined by measuring the spectrum of light transmitted through a semiconductor crystal or reflected off its surface. Information about excitons can also be obtained from the light (i.e., luminescence) they emit when the electron falls back into the hole. The lifetime for such a process is in the range of milliseconds to nanoseconds. This luminescence light can be used to determine the energy distribution of a collection of excitons, the condensation of excitons into more complex particles ("excitonic matter"), and the diffusion or mobility of excitons.

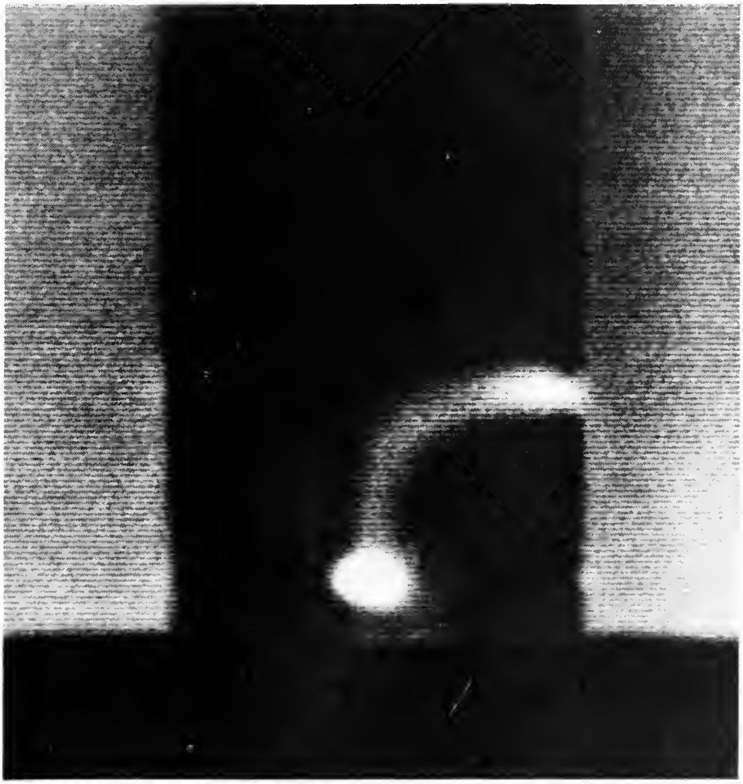
At the University of Illinois at Urbana-Champaign, research programs involving excitons in semiconductor materials can be found in both the Physics department under the direction of Professor J.P. Wolfe and the Electrical and Computer Engineering (ECE) department by Professors N. Holonyak Jr. and G.E. Stillman. Professor Wolfe's group is currently engaged in performing condensation and diffusion type experiments in semiconductors and semiconducting quantum wells, which are produced by Professor Morkoc in ECE by growing the crystals atomic layer by atomic layer (see below). Professor Stillman's group has an interest in further developing light detectors by measuring the photoluminescence of bound excitons (i.e., bound to impurities) in bulk and quantum well devices, and Professor Holonyak's group is mainly studying

these materials for use as light emitters in optoelectronic applications. These groups are supported by the National Science Foundation, Department of Energy, and the Department of Defense.

As described earlier, a compound semiconductor such as GaAs can emit light by the recombination of electrons and holes. Now if a very thin layer of GaAs were sandwiched between two layers of AlGaAs, photoexcited carriers (i.e., electrons and holes) are trapped in the GaAs layer, which forms a "2-dimensional" quantum well. Furthermore, the principal luminescence that comes from a quantum well structure is from excitons. The confinement to 2 dimensions enhances the luminescent intensity of excitons in GaAs. This is because the exciton confined to a 2-dimensional quantum well has a greater binding energy than it would in the bulk crystal. This allows the excitons to be observed even at room temperature, whereas in the bulk crystal, the weakly bound excitons are largely dissociated at room temperature.

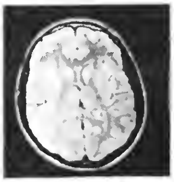
One of the unique types of experiments performed at the University of Illinois is spatial imaging of the exciton motion. Professor Wolfe's group has developed techniques for measuring the "diffusion" of excitons in a quantum well; this is accomplished by using lasers with extremely short pulse duration and focused to micrometer spots onto the GaAs quantum well. The exciton diffusion rate depends on the temperature of the crystal and the power of the exciting laser.

The motion of excitons was graphically demonstrated a few years ago in Professor Wolfe's laboratory, using a single crystal which was stressed to produce a region of low band gap energy to which the excitons are attracted. The accompanying photograph shows the exciton drift from their creation point on the left surface of the crystal to a "strain maximum" just below the top surface of the crystal. Further information about these kind of experiments may be found in the March 1984 issue of **Scientific American**.

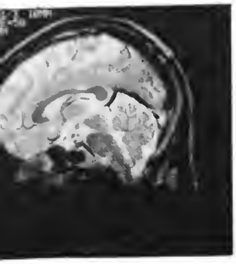


An exciton is observed in a quantum well.

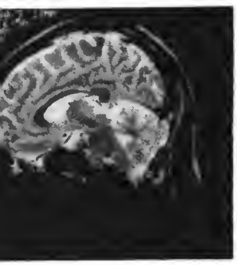
Magnetic Resonance Imaging



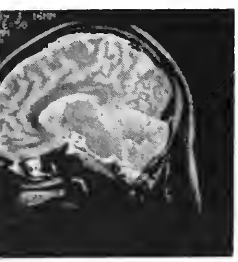
Magnetic resonance imaging, a technology developed mostly during the past decade, is a field exploding with opportunities. The process, which uses strong magnetic fields to examine internal structures and chemical compositions, has a myriad of uses in physics, psychology, medicine, and many other fields. The University of Illinois is playing an important part in the development of this new technology which may yet have unforeseen benefits.



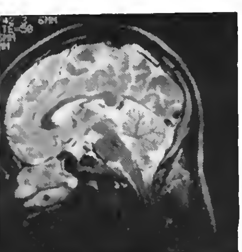
The University's current center of study is located at the Biomedical Magnetic Resonance Laboratory (BMRL) on Park Street. Professor Paul Lauterbur heads the institute's research facilities.



A major emphasis in medical research going on currently at the laboratory includes new applications of magnetic resonance in the field of neurobiology. The facility is also developing techniques for microscopic imaging, in which single cells may be imaged and examined. Other research areas include improving measurements of blood flow in tissues, measuring the local chemical composition of tissues, and developing new kinds of magnetic labelling.

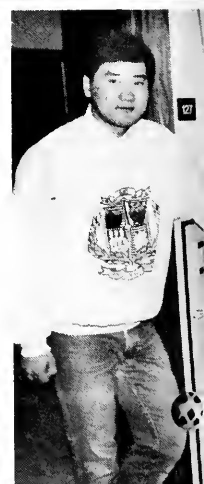


Because of the size of the imager, research is currently constricted to small animals (usually mice). However, the future looks much brighter. On March 22, a ceremony at Beckman announced a $10.6 million federal grant from the National Science Foundation and a $900,000 grant from the State of Illinois. A portion of these grants will go directly towards purchasing the world's most advanced magnetic medical imaging machine. The 4 Tesla device will be installed in the basement of Beckman, and will be used for medical imaging for humans as well as research on a grander scale than that going on at the BMRL.

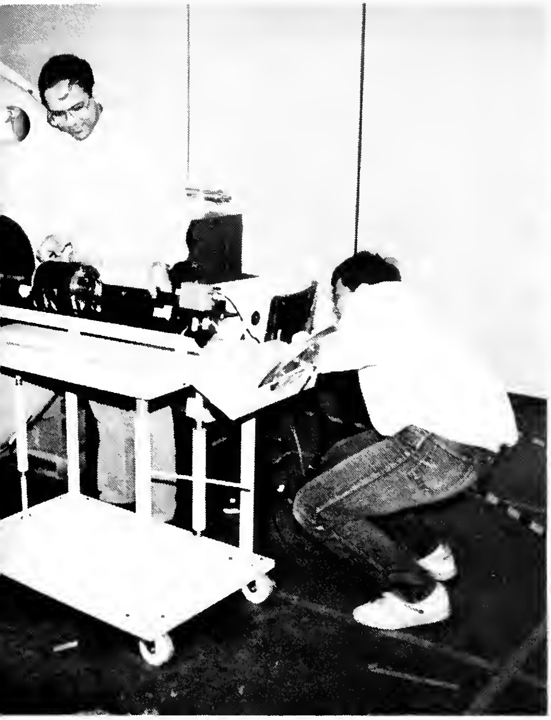


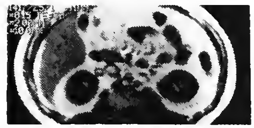
The magnets for the imaging device, about three times more powerful than those typically used in hospital imaging equipment, will be built by the Texas Accelerator Center, which is also responsible for mighty supercollider project in Texas. Professor Lauterbur, highly involved with this project, is also exploring the possibility of building a 10 Tesla human imaging machine.

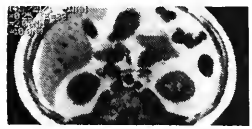
scan images coutesy of DIAGNOSTICS/ PENINSULA IMAGING

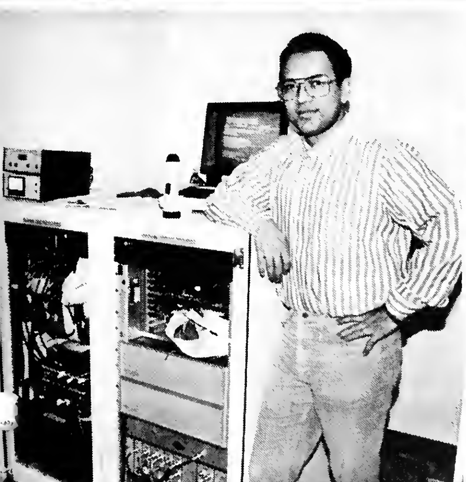


above: A sample is prepared to be scanned by the magnetic resonance imaging equipment. right: The computer which is used to run and process the scans is shown. far right: A BMRL staff member makes repairs on equipment.



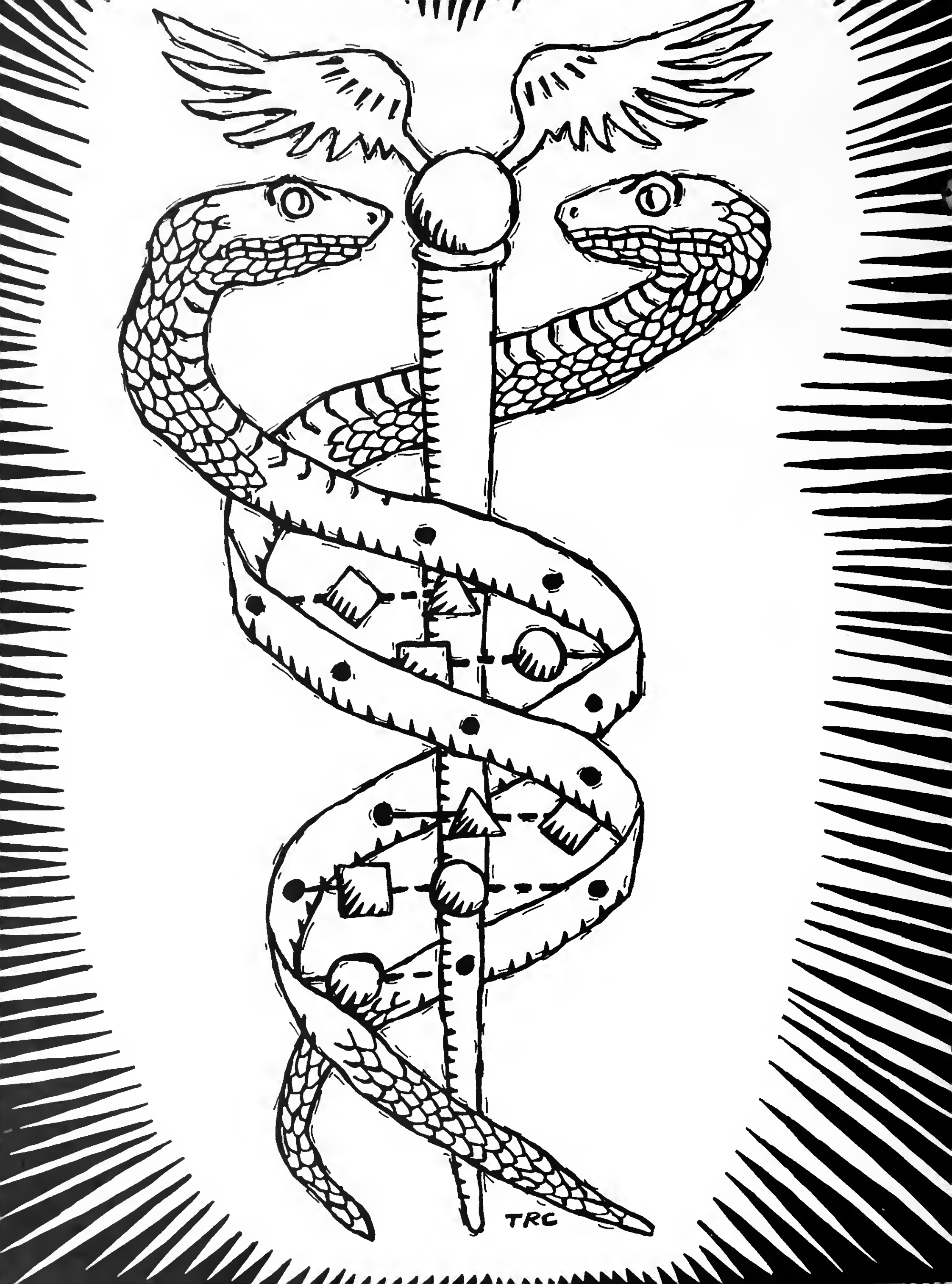






TECH VISIONS

photos by Jim Peroulas


TRC

ethics in GENETICS

why should scientists be concerned?

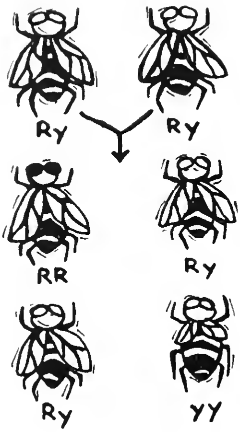
KARA FEDERMEIER

The Webster's New World dictionary defines science as "the systematized knowledge of nature and the physical world." As knowledge-seekers, scientists push back the boundaries of the unknown. By doing so, scientists not only allow humans to know more; they also allow humans to do more. It is this, aspect of science that often creates technological and moral tangles that are difficult, if not impossible, to unravel. Recent publicity for the Human Genome project, designed to completely map human gene patterns and to discover the function of each of these genes has brought to light some of the social difficulties genetic research is creating. The technologies associated with genetics research have left in their wake a whole realm of technological possibilities which the current legal, political, and moral systems of this country are not yet prepared to handle. It is important to confront these ethical issues before they present major problems in society.

A basic knowledge of genetics is necessary to fully understand the issues at hand. In brief, genes are the biological units responsible for the transmission of hereditary (determined at conception) traits. Genes are codes for polypeptide chains, proteins, and enzymes, which are the fundamental parts of biological systems. Genes usually occur in pairs (an organism usually inheriting one gene from each parent), and gene expression (how a particular gene influences a particular organism) depends, in part, upon the dominance or recessiveness of the genes in a gene pair. A dominant gene is almost always expressed; a recessive gene is expressed when no dominant genes for the same trait are present. Of course, this explanation is highly simplified, since blending a combination of genetic traits and regulation by hormones play an important role in determining how genes will be expressed in an organism. What is most important to recognize, however, is that specific genes influence specific aspects of the organism; these genes are, in turn, influenced by other biological features around them. Variations in a population occur, in part, because of differences in genetic makeups. Genetic differences often occur through mutations, changes in the chemical makeup of a gene, which can cause biological changes in the organism; such changes range from helpful to unimportant to lethal. Scientists now have the power to regulate gene flow in a population and even to chemically alter genes to create "man-made mutations." It is this technology, both advantageous and frightening, that confronts society today.

Perhaps the first genetics-related technology to confront American society was sperm donation. This process allows women with infertile husbands to conceive and carry a child through fertilization by a donor's sperm. Immediately, religious problems surfaced; members of religious groups who believe that procreation should be a natural process immediately opposed the idea, and the religious issue remains important for all the genetic technologies discussed in this article. Whether genetics technologies are "moral" from a religious standpoint remains a hotly debated issue — one that does not show signs of being resolved. But sperm donation has created legal, as well as ethical, problems such as the definition of "parent" in sperm donation cases, and the rights and/or responsibilities of the donor father and the husband of the natural mother. The present legal system does not yet have the definitions and guidelines to deal with the new concept of "father" and "mother" that genetic technology is creating.

These problems become more pronounced when another technology, that of the surrogate mother, is examined. In sperm donation, the identity of the donor can be kept from the receiver, and vice versa, so the chances of a sperm donor breaking a contract and claiming the child as his own are very slim. This is obviously not the case with surrogate motherhood. When the gestational mother is different from the "legal" mother, serious legal and religious questions can result regardless of whether or not the "legal" mother was also the donor of the egg. Questions arise such as "Should the surrogate mother be allowed to back out of the contract?", "What if the child is deformed?", "What if the surrogate mother damages the fetus during pregnancy by careless health habits", and "Should the surrogate mother be paid?" Visitation rights, complicated even for adoption, are extremely difficult to deal with in surrogate mother cases. Should the child have the right to know who his/her surrogate mother was? If egg donation is involved should the child have access to medical information about his/her surrogate mother? None of these issues has been resolved, and some have hardly been examined, yet surrogate motherhood is a technology becoming more widely used in America and abroad.



A final example is the newly developing ex utero reproduction techniques. Such techniques would allow for the development of a fetus in an artificial uterine environment for all or part of its gestation period. This idea and its implications shock even some of the less religious groups in society. Legally, the products of such technology would create problems of tremendous proportions. Not only would the concept of parents have to be redefined, but the concept of citizenship would have to be re-examined as well. What would be such a child's country of birth? Lesser problems of inheritance and marriage (defining the relatives of a child born by ex utero reproduction) arise as well. Scientific questions such as how parental bonding and the resulting mental health of the child would be affected have yet to be examined. When and where such procedures could be utilized, as well as what responsibilities society has for such children, brings humankind to the verge of a total redefinition of life and reproduction. All of mankind's "facts" about family and parenthood are being challenged by new technologies which are on the verge of being widely available and which create problems never before encountered in the history of humanity.

These are only the beginning. Such technologies put society on the verge of selective breeding and raise additional social and moral questions. Is it right to artificially manufacture a child? How will such procedures affect the human gene pool? Can such practice lead to the buying and selling of life — or at least the stuff life is made of? Who has a right to information about the genetic background and make-up of an individual?

The questions that genetic technologies raise pose a serious challenge to the structure of human society. Genetic technologies exist and will continue to develop. There is no turning back. And many don't want to turn back because these technologies, in spite of all the problems they present, offer infertile or genetically disadvantaged parents the chance to have normal children. They seem to offer everyone a chance at a healthier and, perhaps, more advantageous life. The problem is, how far and in what direction should these technologies be allowed to grow? It is this question that scientists and non-scientists alike must be prepared to address in the coming years.

Mark Maslov

TECH PROFILE

Professor Burks Oakley

Professor Burks Oakley is a faculty member in Electrical and Computer Engineering and specializes in Bioengineering. "Bioengineering is a broad field", says Oakley, "which can involve just about anything an engineer does." He explains, "Someone involved with fluid dynamics might study blood flow, while someone in engineering mechanics might study bone stresses." Professor Oakley's interest in bioengineering is really just an extension of electrical engineering. in particular, he is interested in how electrical signals flow through the nervous system.

Professor Oakley received a B.S. in Chemical Engineering from Northwestern University in 1971. While there, he became interested in bioengineering, and he went to Michigan for graduate school where he received an M.S. in 1973 and a Ph.D. in 1975 in that field. Professor Oakley went on the University of California at San Francisco to study physiology for three years to get a better background in biology. He then came back to the Midwest to work at Purdue for two years before becoming an assistant professor in the Electrical Engineering Dept. here at the University of Illinois in 1981.

For about the last five years, Professor Oakley has taught ECE 270, an introductory circuit analysis course. He says he enjoys teaching a lot of students, and, with an average of 300 students per class, ECE 270 is the largest class in the department. He likes making a contribution to undergraduate education by helping so many students get a basic ECE (electrical and computer engineering) background. He claims, "It is important for students to get off on the right foot with introductory courses."

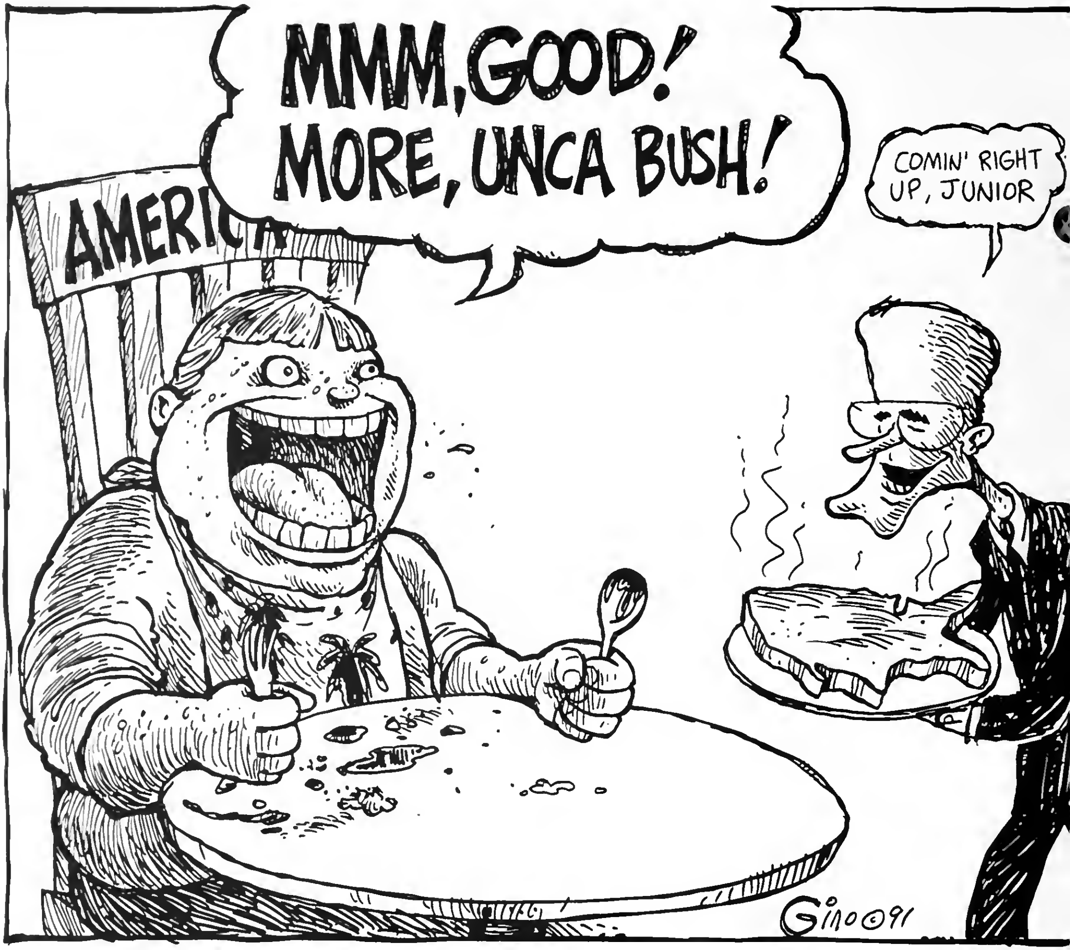
A project Professor Oakley has been working on that relates to ECE 270 is computer-aided instruction. Oakley says that, due to the abundance of computers on campus, this is an ideal way to enhance education. So Oakley has been developing a software package that he hopes will be published for sale with the ECE 270 textbook. Undergraduate students have been helping him with the software. "It's been a lot of fun getting undergraduate students working closely with it. I'm really excited about it," he remarks.

In addition, Oakley is developing an experimental course, ECE 271, which is a combination of ECE 244, and introductory circuits lab course, and ECE 270. Oakley feels that a lab course in conjunction with a theory course gives students a better chance to apply what they learn.

Professor Oakley is currently conducting research on electrical signals produced by the retina. He is researching how the signals are produced and is characterizing signals for different conditions. He is presently working with animal models using electroretinograms, or ERG's, to measure electric signals. The goal of his research is to study how the signals can be measured, how the components of the signals can be analyzed, and what cells in the retina produce the components. Professor Oakley is anticipating that understanding this phenomenon will give insight on some visual disorders.

Professor Oakley is involved in several organizations which give him an opportunity to participate actively and give input on student problems. He serves on the Education Technologies Board which pushes to get more computers in education and develops computer-based education; and has also represented the ECE department the last four years on the University Senate. The University Senate sets policies for campus through committees, and Professor Oakley is the Chairman of the University Student Life Committee. This committee considers campus-wide issues such as alcohol abuse and racial problems. Recently the committee discussed the possibility of requiring a course in cultural diversity. For his involvement in these organizations, Professor Oakley has been honored with the 1991 Pierce Award. He reflects, "It's nice that students think so highly of what I've been doing that I get something like this."

Professor Oakley has a wife and two daughters. He says his daughters keep him busy with their sports activities. In his spare time, he likes to swim and he is also interested in computers. He and his family designed the floor plan of the house, in which they are currently living, on an Apple Macintosh. Professor Oakley certainly has a wide range of interests and takes the opportunity to actively pursue them.



16

A National Energy Strategy? It's up to you.

Steve Vavrik

The National Energy Strategy unveiled today by President Bush is a grab bag of missed opportunities and misplaced priorities. It's a national energy tragedy designed by the oil and nuclear industries and their allies in the White House.
–Howard Ris, Jr., Executive Director of the Union of Concerned Scientists

On February 20, the Bush Administration released the National Energy Strategy (NES). What was once eagerly awaited as a watershed policy proposal stressing energy efficiency focused rather on energy production options much to the anger of environmental and conservation groups. The NES has been introduced to legislation in the energy bill (S.341) proposed by Sen. Bennett Johnston and will undoubtedly face much debate and revision. But one conclusion is already obvious: the NES lacks any serious commitment to energy efficiency and renewable sources.

The main points of the NES concern energy production. To increase national oil reserves, the strategy suggests opening the Arctic National Wildlife Refuge (ANWR) and the Outer Continental Shelf (OCS) to drilling operations. In the transportation sector, commercial vehicle fleets will be encouraged to switch to non-gasoline hydrocarbon fuels. And in power generation, the strategy proposes streamlining the current nuclear power licensing process to a single-license procedure, mostly by reducing the number of public hearings required when construction of a reactor is complete.

What is notably absent from the NES is a call for conservation. No recommendations for increased efficiency or renewable energy measures, no increases in funds for alternative energy R&D, and no programs for science education are present. In his State of the Union address, President Bush spoke of "a comprehensive national energy strategy that calls for energy conservation and efficiency, increased development and greater use of alternate fuels." What happened in between this message and the NES?

Power of the Market

Since mid-1989 the Dept. of Energy has been developing a framework for a comprehensive energy strategy. They gathered recommendations and suggestions from 18 public hearings and solicited comments from various related groups and agencies. During the process, one message stood clear: conservation was regarded as the preferred energy option. "It was interesting for me to discover that the strongest single message that emerged from our pulse-taking for the national energy strategy was the need for increased energy efficiency. This is the case, I think, not just because energy efficiency is good for the environment, but just as importantly because it makes economic sense," commented Energy Secretary James Watkins on June 14, 1990. It looked as if all parties had agreed on efficiency as the foundation for the proposal.

But heavy fire came from the White House. Led by chief of staff John Sununu, budget director Richard Darman, and chief economic advisor Michael Boskin, the opposition contended energy efficiency measures and renewable energy initiatives constituted unacceptable government interference in the free market. Leave it to market-driven energy prices to create incentives to conserve as regulations or taxes would create inefficiencies and slow economic growth.[1]

True, the use of tax incentives and regulations to encourage and reward conservation alters the energy market. But do the present market parameters accurately reflect such externalities as environmental effects? The recent U.S. - Exxon record settlement sets a precedent for including environmental obligations in corporate/industrial responsibilities, but are disasters of the same magnitude as the Valdez spill necessary to impel such actions?

The Current NES

Regardless of market implications, the recommendations in S.341 should be reviewed. Do they match present energy requirements and form the building blocks for a long-term, sensible national energy plan? How would the opening of the ANWR and OCS specifically benefit the national energy condition? Federal government figures estimate 6.1 billion barrels of oil equivalent, approximately 3.2% of the nation's total reserves (187 billion barrels), lie within the ANWR and the OCS outside the central and western Gulf of Mexico.[2] Once obtained, these resources could only supply a small amount of the total future U.S. oil consumption. According the the U.S. Geological Survey, even if all such protected lands were opened, drilled, and exploited to full capacity, it would only supply about one year's worth of oil based on the current consumption rate. Natural Resources Defence Council attorney Ralph Cavanagh states, "We would wait seven to ten years for the first deliveries, and they emphatically would not be cheap...The drilling strategy offers at best a temporary dribble of expensive oil, helping to prolong an addiction that ultimately can be sustained only through steady increasing Persian Gulf imports."[3]

The effects of a drilling operation extend beyond the drilling site. The Dept. of Interior estimates 22 to 46 major oil spills would occur if the current OCS Five-Year Plan is continued. According to the National Academy of Sciences, drilling a single well produces 1500-2000 tons of drilling muds and cutting, much of it contaminated. The waste water from the drilling operation, contaminated by oil, grease, cadmium, benzene, lead, and other toxic organics and metals, is routinely discharged back to the surrounding well environment. In the case of the Arctic National Wildlife Refuge, the surrounding is a South Carolina-sized area of pristine wilderness. One of the world's largest strongholds for arctic wildlife, the ANWR is home to the 165,000-member Porcupine caribou herd, which shares the refuge with polar bears, grizzlies, wolves, musk oxen, and millions of migratory waterfowl and other birds.[4]

Alternatives

Fine. More oil drilling is not the ultimate solution, but are there any other attainable options? Yes, in energy efficiency. "Increases in oil costs can only be mitigated by increases in energy efficiency," says NRDC energy analyst David Goldstein. Transportation accounts for 60% of the nation's oil consumption, relies on oil for 97% of its energy requirements, and is one of the areas where efficiency measures can most readily be implemented. An increase in automobile fuel economy standards to 40 mpg could save as much as 8 to 9 billion barrels of oil by 2010. In contrast to positions by the U.S. auto industry, foreign manufactures such as Renault and Volvo have responded by creating cars with city efficiency ratings at 63 to 100 mpg, highway ratings at 81 to 146 mpg![5] In addition, carpooling and increased use of mass transit could dramatically reduce fuel consumption. Off road, home energy efficiency can be improved by fully insulating exterior walls, replacing single paned windows by multipaned insulated ones, and using compact fluorescent light bulbs which require 25% of the energy while lasting nine times longer as compared to conventional incandescent bulbs.

Improved efficiency measures can also be applied to other areas. Home appliances such as refrigerators, washers, and water heaters can have efficiency standards similar to automobiles, and some public utilities are now promoting efficiency through programs and projects. Finally, support for research and development for energy efficiency, renewable energy, and transportation alternatives should not only be continued but expanded.

Your opportunities

These policies are, of course, of national scope, and the role of the individual, let alone the typical student, seems negligible. But the individual level is where many policy programs originate and take root. Instead of driving, walk, bike, or use the MTD to get to class or across town. Recycle cans, cardboard, and glass. Use canvas or net bags rather than paper. By recycling and reusing, you eliminate the demand for the energy and resources required to replace the product. Compact fluorescent light bulbs, although relatively expensive (about $16), make creative and thoughtful gifts. Also, low flow water nozzles on your shower and sinks conserve water and reduce the energy your water heater will require.

Get involved in community groups. Volunteer some time at your local recycling center. Or, if your community does not have a center, look into what it would take to start a group. At your summer job or new career, inquire about what your company/firm is doing to conserve and investigate other efficiency options that could be implemented. Many organizations offer "rewards" for cost-saving ideas by returning to you a percentage of the actual total savings. Talk to others and inform them about efficiency measures. Consider a career in developing and manufacturing energy efficient and renewable energy technologies — the work would most certainly be exciting and quite rewarding.

Conclusion

Above all, examine the controversies surround the NES and the energy legislation debates that will certainly follow. Both emotional pleas and bottom line calculations will be widely used tools of persuasion in these argument. Should we sacrifice natural resources in order to feed a huge energy appetite? Should we let supply and demand reach equilibrium without guidance? How do we accurately evaluate the need, price, and environmental consequences of each option?

Central to the NES debate are the roles in terms of magnitude and direction of energy production and conservation. For the first time, energy conservation is being supported for reasons other than market forces. The integration of conservation *for the sense of conservation* into federal policy discussions is a milestone event. Oil leaders are not playing supply games. Rather, U.S. scientists, engineers, policy-makers, and citizens are the ones promoting conservation as the better option.

Over the past two decades, conservation and environmental awareness has increasingly diffused into the mainstream attitudes to the extent that it has finally penetrated national policy construction as a legitimate consideration. The focus of global policy-making is shifting from security to environmental concerns, and a new era is beginning. As college students, we are in extraordinary positions. Standing on the fringe of this new period while surveying various career paths, we not only take to our careers and lifestyles these transferred attitudes, we carry the responsibilities of successfully implementing these attitudes, ensuring their further expansion and development, and delivering them to the next generations.

Steve Vavrik is a graduate student in mechanical engineering and newsletter editor for the Society of Scientists for the Environment.

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[1] "Admiral Watkins's leaking energy policy," The Economist, 23 February 1991 p. 30.

[2] Dwight Holing, "America's Energy Plan: Missing in Action," The Amicus Journal (National Resources Defense Council) 13 (Winter 1991): 14.

[3] Ibid.

[4] Ibid., pp. 15-17.

[5] Ibid., pp 18-19.

1. There were several answers to the problem. The winning answer was as follows:

$$\frac{\tan\left(\frac{5\pi}{14 + (5+5) \times \cos\pi}\right)}{5 + 3\cos\pi} = \frac{1}{2}$$

The winning answer was submitted by Ken Smith, a graduate student in Mechanical Engineering.

2. The area of the smallest triangle is $$1000 + \frac{1750}{\sqrt{3}}$$

or approximately 2010.36

Congratulations to Robert E. Miller, Professor of Theoretical and Applied Mechanics.

3. In order that a number be expressible as the sum of two squares, it must be a composite of the form 4n+1 which is prime. For example, (5x13x17x29) can be made into 8 different groups of two squares. The smallest number that can be expressed as the sum of two squares in twelve different ways is 160,225 (5x5x13x17x29)

Daniel Lewart, Graduate Research Assistant in Physics, was the only one to submit the correct answer.

this issue's TechTeaser solutions

1. The ages of Professor Bob's children are 6 and 10.

2. Muffy has three possible answers to choose from:

$$\begin{array}{r} 94{,}867{,}312 \\ \times\ 6 \\ \hline 569{,}143{,}872 \end{array} \qquad \begin{array}{r} 89{,}745{,}321 \\ \times\ 6 \\ \hline 538{,}471{,}926 \end{array} \qquad \begin{array}{r} 98{,}745{,}231 \\ \times\ 6 \\ \hline 592{,}471{,}386 \end{array}$$

3. Twelve shuffles are necessary.

4. Each person will travel 200 yards.

Technograph is expanding and we need your help!!

The Technograph is seeking editors for next year to cover an expanding workload. Editors will be responsible for departments or columns. Applicants should have initiative, know how to work with people, and have leadership ability. Previous editorial experience is preferred but not required. Call 333-3733 (Illini Media office), and leave your name and phone number if you are interested.

october 1991
volume 107
issue one

illinois technograph

october 1991
volume 107
issue one

features

departments

next issue: november 4

These problems could win you money! All you have to do is mail your answer(s) for any or all of the problems, with your name, address, and phone number to
Tech Teasers
Illinoi Technograph
Illini Media Company
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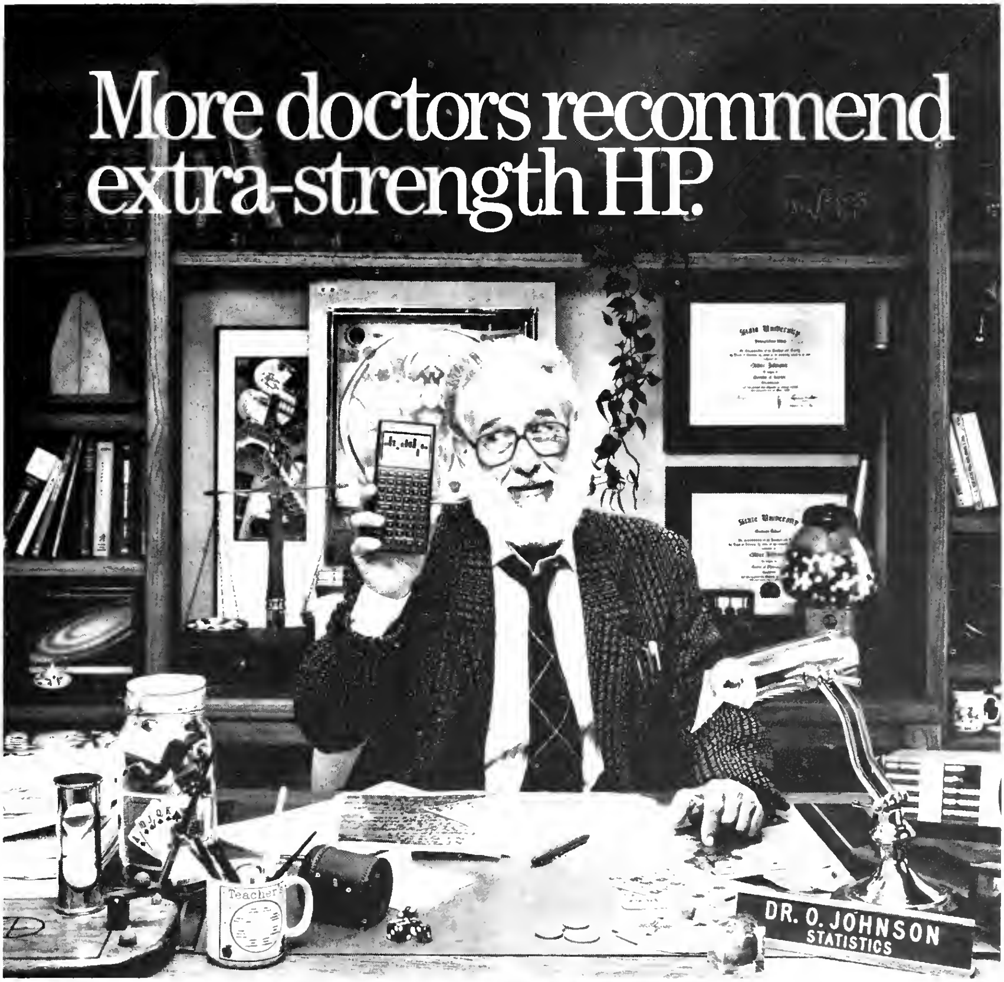
Champaign, IL 61801

The first person to submit a correct answer for a problem will win the amount specified for the particular problem. In case of a tie, a name will be drawn from the entries to deterine a winner. This contest is not open to employees of the Illini Media Company.

tech teasers

one a University of Illinois tour guide leading a group of visiting high school students down Green Street gave the following information regarding landmarks: The height of Altgeld Hall in rods is three less than twice the height of Everitt Lab in rods. The height of Altgeld plus half the difference between the ages of Engineering Hall and the Illini Union, respectively, in decades. The sum of the ages of the Illini Union and Engineering Hall, in decades, is twice the sum of the heights of Altgeld Hall and Everitt Lab in rods. The Illini Union is half as old as Engineering Hall will be when it is four times as old as the Illini Union was when it was a third as old as Engineering Hall will be when it is half as old as the Illini Union will be when it is two fifths as old as Engineering Hall will be when it is six times as old as it is now. How tall is Everitt Lab? (Note: Heights and ages of building are not based on actual data.) **[$15.00]**

two two reckless bicyclists are travelling toward each other from a distance of one mile. The first is moving at a speed of 22 miles per hour, and the other is moving at a speed of 15 miles per hour. At this instant, a fly leaves the first bicyclist at 30 miles per hour and heads for the second bicyclist. When it reaches the second bicyclist, the fly instantly turns around without changing speed and heads back toward the first bicyclist. The fly keeps doing this until theye collide. What is the total distance travelled by the fly? **[$10.00]**



More and more PhDs across the country are recommending Hewlett-Packard financial and scientific calculators to their students. And for some very strong reasons.

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HEWLETT PACKARD

bach box

Imagine dancing to music you are performing with your movements. Translating dance into music has been a dream of inspired students in Ricardo Uribe's ECE 246 class since 1988. The theoretical idea for this merger of two art forms came from Chris Pressinges, a former University of Illinois music student. David Cadmas transformed this vision into the Bach Box, a micro-controller that receives video input of a dancer and subsequently converts the image of the dancer's movement into commands readable by a tone generator.

The Bach Box accomplishes the conversion from movement to computer code using an image processor that detects changes from one frame to the next. Overhead video camera input is received by the Bach Box at the rate of 30 still pictures per second. One frame is mapped in X-Y coordinates and stored in erasable read only memory while a second frame is analyzed for changes from the original image. Furniture and other motionless objects will not interfere with the music because the Bach Box only detects what is different on the dance floor since the last frame. The X-Y coordinate differences in the two frames are sent to a digital signal processor that converts the differences into code. A tone generator acquires these commands and produces a corresponding musical note.

Sangay Agrawal, computer engineering senior, and Dave Black, senior in computer science, are interfacing the microcontroller to a tone generator this semester. The program for the C26 digital signal processor chip is being written by graduate student Rob Mqown. Agrawal believes a working prototype of the Bach Box will be finished at the end of the Fall Semester 1991.

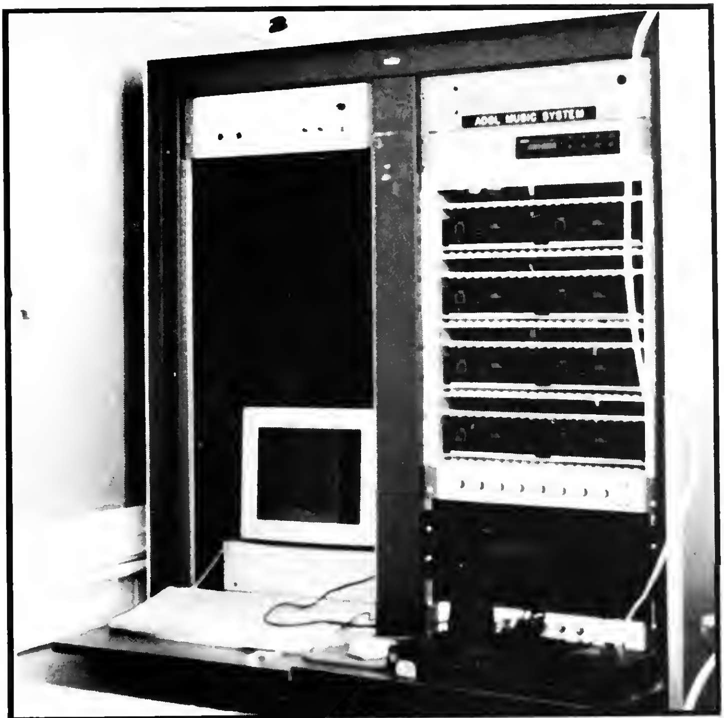
Matching the velocity of the dancer to the tempo of the music is the next step, according to Agrawal. A performer will be able to change the tempo by moving faster or slower. This feat will be accomplished by using a second video camera mounted horizontal to the dancer.

The engineering students also plan to assign orchestra lists to various areas on the dance floor. The performer could then move to one corner and signal a symphony to play or dance into another area and the notes created would be performed by a jazz band. The mood of the dancer will truly control what the music sounds like. The Bach Box lends a whole new meaning to the term "air guitar", consider "air orchestra" contests without prerecorded songs.

Building your own interactive dance floor may be a possibility in the future. Agrawal estimates the Bach Box, if mass produced, would sell for around $200. This price does not include a video camera, amplifier or speakers. Presently a demonstration of the Bach Box principles can be produced using a MIDI sampler program and mouse connected to a personal computer. The MIDI sampler allows the user to affect music by moving the mouse.

The Bach Box is an incredible step in the progression of art forms as well as technology. From the first hollow bone instruments and pottery drums 6,000 years ago, to the music synthesizer, human beings have continued to strive for new ways to create music. The Bach Box takes musical performances a step further by freeing humans from instrumental constraints.

patrick carmichael



a quick shot at the bach box setup in the Advanced Digital Sciences Laboratory. The Macintosh sits on the left, the tone generators and digital processors to the right.

Art and music have had a tremendous impact on the history of engineering. Engineers have diligently worked out solutions to problems facing the artist throughout history. From musical synthesizers to pottery wheels, the engineers' innovation has played a key role in artistic development. Whenever the engineers idea pool ran dry, the artist himself took over.

The first sculptures were carved from stone, and as time went on man changed his methods in order to create a more accurate representation of his visions. In time, metals evolved and their usefulness appreciated. This gave rise to

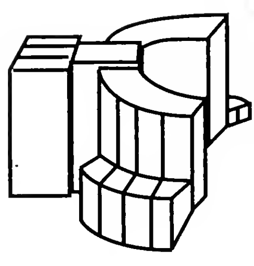
The Flourishing Relationship of Art and Engineering

Dan Santner & Srilata Raman

several metal casting methods such as the wax process. For the sculptor, knowing either the science of castings or enough about carving was not enough. The sculptor had to be a master of both. This artist had to develop the skill of making the wax mold and deciding which alloy composite would represent the texture and color he had envisioned. He thus became engineer as well as artist.

In our modern world, there are several very abstract forms of art. The forms range from 'simple' paintings and sculptures to high tech trick photography. Computer graphics and imaging has developed as a relatively recent genre of expression, but already there are art galleries which cater to high-technology forms of art.

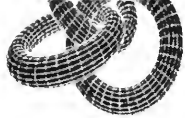
One of the newest forms of art that is emerging is a sort of amalgamation of supercomputers and imaging. With the ongoing development of more sophisticated computers, teams of graphical experts are forming to work together and create visual representations of data. One such team is fostered right here at the University of Illinois in a twentieth-century work of art itself, the Beckman Institute. The project, part of the National Center for Supercomputing Applications (NCSA), aims to add another dimension to the methods by which scientists analyze their data. *Scientific visualization* is the phrase that is hopping around the research community and it seems to be quite a hot jingle.



The project aims at using the supercomputing power of such computers as the Cray to develop a means by which engineers and scientists can visualize physical processes. In a way, the artistic propensities of the gifted are proving to be quite useful in some fields of engineering and a trend is growing. Applications already exist in the areas of fluid dynamics, electromagnetism, and even plasma physics.

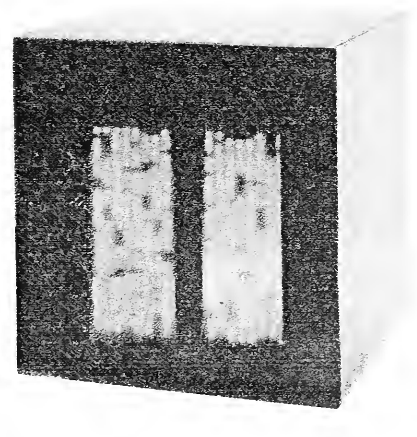
Recently Parkland Community College began offering a pioneer program in computer graphics directed by Dick Bennett and taught in the Beckman Institute's Renaissance Experimental Laboratory (REL) by Ray Idaszak and Mike Krogh. This year 13 students are expected to graduate from the "Advanced Certification Program for Visualization Computer Graphics Specialist." These students, upon completion of the program, have the new and exciting challenge of drawing together the engineering disciplines and the artistic ideas of visualization technology. They are the engineers/artists that will become the sculptors of the future of science.

Audible art has not been untouched by engineering either. Music has relied upon fundamental engineering concepts for time immemorial. In the eighteenth century when Mozart and his peers wrote their music there was no electricity. Musicians relied solely on the capabilities of the violins and other instruments. When one thinks of the violin, one can immediately see the significance of the dimensions of the instrument: the tension in the strings and the materials used to construct the voilin are only two aspects of the engineering in play. These aspects are in fact directly related to the discipline of acoustic engineering. It is this knowledge of how sound travels that helps people design excellent concert halls. Today, additional aids are available as well, such as microphones, loudspeakers, amplifiers and the like which have invaded the concert halls and banquet rooms in order to help the sound travel farther.



Modern music has great diversity but all forms have a common thread; the creation of sound that is new. In a sense, engineering has gone beyond the limitations of the physical skills of musically inclined. Today there are electronic music synthesizers simple enough to be used by a child to make music at home. At the same time, there are world famous artists such as Karlheinz Stockhausen, Jean Michele Jarre, Alan Parsons, and Laurie Anderson who use synthesizers in the creation of their works. Frank Zappa even went as far as completing an entire album without ever recording one instrument. The album was done on the *Synclavier*, a musical computer/keyboard that will actually record the musical composition as it is played by the artist and record the information on disk. With the advent of digital music, such musical workstations as the *Synclavier* or the *Kurzweil* have become common place in the studios. A musician can create his song at home on his personal (less expensive) music system, record the information on a computer disk, and then bring it to the studio to be recorded. There are now microprocessor-based keyboards that the novice musician can obtain for as little as $1500; these produce CD quality sound and incorporate a real time editor. So an innovative novice musician can try his ideas out and half-live the life of a professional. The only remaining frontier for the musical instrumentation industry is to transfer the thoughts of the musician into musical data signals. Imagine the effect (note: see the bach box article). If only Mozart could see us now!

Figuring out where lies the future of engineering is half of the fun of being an engineer. One thing that is for sure is, as in the words of Donna Cox, NCSA Associate Director for Numerical Laboratory Programs and Art and Design Professor, the continued relationship of art and engineering will have a "major societal impact" or more precisely will *continue* to have a major societal impact. Timothy Ferris sums it up best: "The delights of science and mathematics are too profound, and too important, to be left to scientists and mathematicians alone. They belong to the cultural heritage of the entire world, and to know something about them is to be acquainted with the finest new achievements of the human mind."



The basic processing module of the Connection Macahine (CM-2), a massively (!?) parallel supercomputer manufactured by Thinking Machines Corporation.

The Connection Machine system is a fundamental part of the visualization projects at the Beckmann Institute.

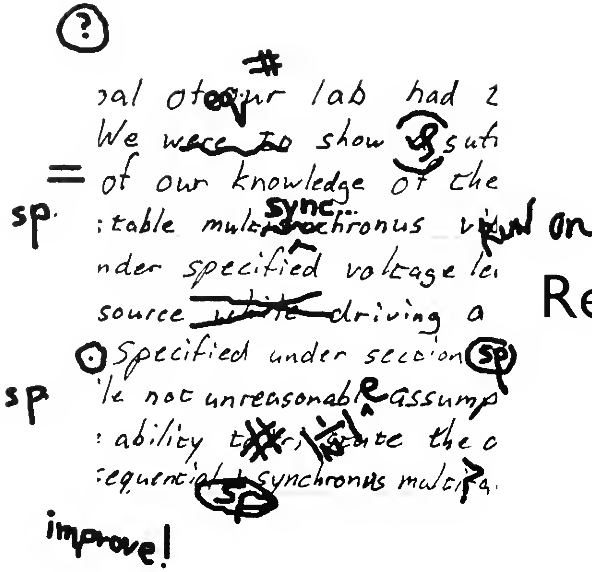
A survey by the American Society of Engineering Education tallies complaints about technical writing from 182 senior officials in science and industry.

Complaints	# responding
Generally foggy language	182
Inadequate general vocabulary	173
Failure to connect information to point	169
Wordiness	164
Lack of stressing important points	163
All sort of illogical reasoning	163
Too much "engineering gobbledygook"	160
Poor overall organization	153
No clear overview	143
No clear continuity	142
Very little concept of writing for anyone but specialists	136
Poor grammar	133
General lack of flexibility to suit circumstances	127
Deliberate obscurity	92
Poor punctuation	81
No sense of proper tone for circumstances	72
Poor adaptation of form to purpose	64
Almost meaningless introduction	54

survey says...

The American Society of Engineering Education conducted a survey to determine which academic subjects are most needed for engineering careers in industry. Responses were received from 4057 engineers, all having at least several years of on-the-job experience.

rank	subject
1	Management practice
2	Technical writing
3	Probability and statistics
4	Public speaking
5	Creative thinking
6	Working with individuals
7	Working with groups
8	Speed reading
9	Talking with people
10	Business practice
11	Survey of computer uses
12	Heat transfer
13	Instrumentation & measurement
14	Data processing
15	Systems programming
16	Economics
17	Ord. differential equations
18	Logic
19	Economic analysis
20	Applications programming
21	Psychology
22	Reliability
23	Vector analysis
24	Electronic systems eng.
25	Laplace transforms
26	Solid-state physics
27	Electromech. energy transform.
28	Matrix algebra
29	Computer systems eng.
30	Operations research
31	Law practice
32	Information & control sys.
33	Numerical analysis
34	Physics of fluids
35	Thermodynamics
36	Electromagnetism
37	Human engineering
38	Materials engineering



Reaching Out

Improving
Engineering
Discourse

The terms "writing across the curriculum" and "multidisciplinary discourse" have been bantered about quite a bit in academic circles for a number of years. However, the University of Illinois is working to turn those terms into effective communication strategies for students and educators across the Urbana-Champaign campus. University requirements will soon include two semesters of composition for all students. The big question soon becomes where to put that second semester of writing studies.

Instead of adding another semester of rhetoric, some departments are choosing to integrate more writing into classes that students are required to take within their majors. For engineering students, this means practice with technical writing and laboratory report writing as well as writing about engineering related issues. Some courses

Through Writing

proposed to be accepted as "writing intensive" courses include AAE 241, AgE 298 and 299, ChE 374, ECE 244 and 345, GE 292, CerE 297, ME 205, Phys 319, and TAM 293 and 294. Already, some of these courses have increased their emphasis on technical writing. Educators in engineering hope that this extra practice for students will hush the growing cry from employers that graduates do not have the writing skills necessary to communicate on a professional level.

But that professional level of discourse is difficult for students to achieve without extensive help from well-trained writers. The "writing across the curriculum" movement has brought a useful resource to the University in the form of the Center for Writing Studies (name pending approval). In addition to establishing a multidisciplinary graduate program in rhetoric and composition studies and assisting faculty who wish to implement more writing in their classrooms to fulfill the new composition requirement, the Center for Writing Studies also helps students in need of help with writing assignments. For the past year, the Center has operated the Writers' Workshop located in the undergraduate library. This workshop, which held over 2500 appointments in 1990, will help students with any part of the writing process and will arrange 30-minute appointments or sessions on a walk-in basis.

Analysis of the students served in the first year of operation reveal that most students are not in need of heavy remediation. Instead the Workshop functions as a "sounding board" for students to be helped with their own writing. Students can bring their papers in on disk if they wish to work on an IBM or Mac during their tutorial. Tutors will not proofread, correct, or offer grade assignments on papers, but they will offer strategies to help with grammar problems and to aid in student proofreading. In addition, the Writers' Workshop contains a growing library of books on writing and handouts dealing with writing problems and frequently asked questions.

In response to a large number of engineering majors that have utilized the facility in the past year, the Writers' Workshop is moving a satellite branch to the Engineering Library north of Green St. Professor Michael Pemberton, Director of the Writer's Workshop, says that this will enable Engineering students to more easily have access to tutors and other opportunities that the facility provides. Ruth Yontz and Carl Alstetter of the College of Engineering received an Apple Core award consisting of four Macintosh IIsi computers and an Apple LaserWriter for use in the satellite Writers' Workshop. These computers will allow students to consult with tutors about papers on disk, make revisions and notes, and allow students access to the computerized catalog system for information concerning research problems.

At present, the tutors for both workshops come from various majors. Professor Pemberton hopes that sometime in the future more tutors from engineering fields will become available. The Writers' Workshop at 251 Undergraduate Library and the Satellite Writers' Worshop in the Engineering Library will provide students from all majors the opportunity to take advantage of learning opportunities which are fashionably called "multidisciplinary" by academians and necessary by the professional community.

joan leach

new computer applications

thomas nam

Astrophysicists from the University of Illinois and Princeton University have developed the most accurate computer model of galaxy formation in the early universe. The model utilizes the resources of the U. of I.'s National Center for Supercomputing Applications (NCSA) to present the most comprehensive visualization of the structure of the early universe. The research team that developed the model was led by astrophysicist and astronomer Michael Norman of the University of Illinois and by the chair of the astrophysics department at Princeton University, Jeremiah Ostriker.

The project goes further than Princeton's previous model, the first to incorporate ordinary matter as well as "dark," or invisible, matter and gravity. "Ostriker and his colleagues have been able to take their model to the next step – considering the effect of stars and galaxies on the development of the universe," said Norman.

The new galaxy formation model was first simulated on Princeton's CONVEX C220 supercomputer. The model covers 90 percent of the age of the universe, starting about one billion years after the big bang. It takes a giant cube section of the universe, approximately 200 million light-years wide, divides it into four million smaller pieces, and then calculates what happens in each piece. The 250 hour simulation produced ten billion bytes of data.

This data was shipped via computer network to NCSA's CONVEX C240 supercomputer. Using NCSA's "Cosmology Explorer" software, the researchers created visualizations of their galaxy formation model on the C240; afterwards, they manipulated the visuals on a state-of-the-art workstation.

A short segment of the visualizations shows, for example, galaxies color-coded by generations. The first generation might appear in a big burst at the beginning, and then the rate of formation would slow down. Eventually, the galaxies would form into the features of the universe as we know it today, including clusters, superclusters, and the voids which separate superclusters.

The next step in the project is to run larger simulations at a higher resolution. The research team will also utilize the NCSA Connection Machine Model 2 (CM-2), a much faster machine for simulation purposes. The researchers from the U. of I. include Norman and Deyang Song, a graduate student in computer science. The collaborating researchers from Princeton include Ostriker, Renyue Cen, Antony Jameson, and Feng Liu.

mark maslov

class at a glance

me 280

The department of Mechanical Engineering's senior design course, ME 280, gives ME students an opportunity to create and present their own designs. Taught by Dean Carl S. Larson, students work all semester in groups of three or four on projects which are submitted to companies which sometimes actually consider implementing the designs.

The projects ME 280 students work on cover a variety of mechanical engineering topics. For example, one recent project is a light-reflective system to align the wheels of a John Deere tractor. Another project is a design for a steam roller which vibrates in order to compact asphalt more efficiently. Other projects involve designing machines that assist physically disabled people. This is only a small sampling of typical ME 280 designs.

Says Dean Larson, "The projects are like homework in other classes, only... you can't get the answer by re-reading the chapter." Additionally, because the projects tackle authentic problems, they are more realistic. A project will most likely require a student to draw on information from several courses. Dean Larson pointed out a project where students must find ways to recycle plastic automobile bumpers. This project differs from a typical design problem in that its scope extends beyond mechanical engineering.

A diversity of skills are needed as well, since technical writing and oral presentations are important parts of the course. While it is important to have a good design, it does little good if one cannot communicate the design clearly to others. Professor Gieselman occasionally gives lectures on technical writing to inform the students on how to write their projects reports. Students also give several oral presentations; a proposal presentation, two progress reports, and a final presentation. All of the presentations are videotaped and shown both to the students so they can observe their own speaking styles, and to the company that has a stake in the project.

ME 280 classes are informal, with Dean Larson's teaching assistants take much of the responsibilty of managing the course. Generally, Larson does not lecture, but instead advises students on their projects and checks their progress.

Dean Larson quickly wins his students over with his interest in their design projects. Only a few weeks into the semester, students are impressed with his willingness to share his "vast amounts" of experience. Dean Larson's goal is to create an environment where people are motivated to work. He claims that because there is plenty of enthusiasm, he doesn't have to push his students; but his own enthusiasm for the projects must influence his students attitudes.

Brian Vicich, senior in ME, says, "I like this course better than anything else I've taken at the U. of I. There isn't the pressure of taking tests; it's just up to you to do the job." This seems representative of the students' opinion of the hands-on experience the course offers. The students say that the problems are more challenging in a design course than in other courses, and that they learn more by doing than by just listening to a professor lecture.

Regarding the course material, Dean Larson states, "I think it's very good experience for students." The projects require a good knowledge of basic principles covered in earlier courses, so they give the students a chance to use what they have learned. Plus, giving presentations is a skill the students will need in the workplace.

ME 280 gives students experience working real-world problems. Courses like this are important, because as an undergraduate student, it is easy to forget that out in the "real world," real engineers create real designs that people can see, touch, use – not designs that exist only in a textbook.

1

CSO UIUCnet dial-up service.
Authorized Use Only
enter "helpme" for more help than thelp:
enter "motd" for messages of the day

mossberg>rlogin uxa

2

Trying UXA.CSO.UIUC.EDU (128.174.2.3).
Open
login: *yourlogin*
Password
Last login: Sun Sep 29 13:28:57 from uxa
DYNIX(R) V3.1.1 NFS #2 (bob): Fri Aug 30 12:23:53 CDT 1991

Some bulletin here

Maybe another bulletin here

If you terminal is not the type shown, enter your terminal type at the prompt
TERM = (vt102)

1>

john fultz

uxa notes

Two years ago, the Computer Services Office (CSO) started giving away computer accounts on a machine called uxa to all incoming freshmen. Although this program has been a reasonable success, many students don't realize what they can gain from their uxa accounts; some don't even know what uxa is. This is the first installment in a series which explains how you can utilize your uxa account to its fullest.

To explain briefly, uxa is one of the many mainframes on campus run by CSO. Although many of the other mainframes are reserved for research or classes (some programming courses require ux1 accounts, for example), uxa is the machine primarily used by the undergraduate students of the University. Uxa is also hooked into international computer networks, allowing access to computers and information all over the world. Although this is certainly convenient for the researcher, undergrads may benefit as well.

Some of the things one might do with uxa include e-mailing (electronic mailing) or talking to friends across the world, participating in discussion groups with dozens of people on campus or across the English-speaking world on almost any topic, getting up to date information about campus events, activities, and groups, transferring public domain and shareware software from hundreds of computers across the world, and working with EPO (Engineering Placement Office) to find a job after graduation. In this first installment, we'll discuss getting your account up and running, as well as electronic mail. Now, dig out that letter you got from CSO, and let's get going.

First of all, I should stress that much of what will be covered in this column is also covered in the Computing Handbook for Students. You may find this at many CSO sites, including Room 8, English Bldg., and it is a good introduction the uxa account. However, we will cover a few things the book does not, so stick around. Anyone with problems with their accounts or seniors who do not have accounts may wish to visit the English Bldg. Finally, remember that an account on uxa, or any mainframe, is a privilege and not a right. CSO reserves the right to revoke your account at any time if you misuse it.

HOOKING UP TO UXA. If you have a computer with a modem, hooking up to uxa is relatively convenient. Simply set up your modem for a baud rate up to 2400 and full duplex (these settings may be standard in your terminal program) Then dial 333-4000. This number routs you to either Mossberg or Term1, which are remote connection servers. This means that these servers will take a phone call and send it to the machine you request. To request uxa, type: **rlogin uxa** *(See Figure 1)*.

If you are using a machine in a computer lab, things are a little simpler. On an IBM select the menu option which corresponds to connecting to a remote machine. When asked for the machine name, type uxa. On a Macintosh, there should be a file called uxa which will automatically connect you. If you have questions, ask the operator in the lab.

LOGGING IN. At this point, uxa asks for your login. Simply type in your login as it was given to you by CSO. Remember that everything in uxa is case sensitive, so you should have your CAPS LOCK key off. After a short pause, uxa will request your password. Type in your password as it was given. Note that you will not be able to see the password as you type it in. This keeps other people who are watching you from seeing your password as well. If you are connected from your personal computer, it will ask for your terminal type. Again, check your modem program and documentation to see what terminal type you are using. Some of the more popular ones include ANSI and VT100. If

the terminal type is correct as shown, you may simply press ENTER. If not, then type in the correct one. At this point, you should see something slightly resembling *Figure 2*.

Something you should pay immediate attention to is changing your password. Type **passwd** to change your password. You will need to type in your old password, type in a new password, and type in the new password again to confirm it. Be careful to choose a password that is not obvious, like a birthdate or a boy/girlfriend's name, etc.

EMAIL. You now may be so happy that you wish to tell everyone else that you're on uxa. One of the best ways to do that is to send them e-mail. But first you have to know their e-mail addresses. For someone off campus, you will have to find out their e-mail address by phone or U.S. mail or some interpersonal contact. However, the process is much simplified if the person you wish to e-mail is on campus. A program available to uxa called **ph** (ala phonebook) stores every student and faculty member's name, address, phone number, and e-mail address. To **ph** someone, simply type **ph Firstname Lastname**. Do not use nicknames for the first name (e.g. use Michael, not Mike). You could simply type in the last name and get a listing of all people with that last name. You may want to write down the e-mail addresses of the people you wish to send mail to.

MAIL. One of the commonly used programs for sending or checking mail is, aptly enough, **mail**. To send mail to someone, type **mail e-mail_address**. You will be prompted for a subject. Type in a subject of the letter, and press ENTER. Then type in your message. Note that **mail** does not have word wrapping, so press ENTER at the end of each line. When you are finished, go to a new line by pressing ENTER. Then press the control key plus the D key. Uxa replies with a new line: **cc:**, asking if you wish to send carbon copies of this letter to anyone else. If you do, type their addresses, each separated by a space. If not, press ENTER. Now your mail is sent.

If you wish to check your mail, simply type **mail**. If you have mail, a numbered list of the messages will be displayed. Type the number of the message you wish to read, or keep pressing ENTER to read the mail in order. To delete a message, type **d#** (where # is the number of the message). To reply to a message, type **m#**. To quit the mailing program, type **q**. Confused? There is an easier option.

ELM. Elm is an alternative mailing program which is a menu-based and generally easier to figure out than mail. To use it, simply type **elm**. If you have never used elm, before, you should see something similar to *Figure 3*. Just press ENTER to the questions, and the program will automatically set up elm for you. The elm program screen looks like *Figure 4*. If you have messages waiting, they will be listed at the top of the screen. Type the number of the message to select a message. Then follow the prompts. If you type **m** to mail a message, you may follow the prompts similarly to the **mail** program. The difference is that, to write the letter, **elm** uses your preferred text editor, which has probably been set to **vi**. If you don't know how to use **vi**, you may get reference sheets on it from CSO. Otherwise, you may wish to use **mail** for the time being.

Here are some other commands you might want to try while waiting for part two of this series. Have fun.

man *command* (where *command* is the command you want the help for)
finger *e-mail_address*
w (stands for what)
who
pi

3

3> elm

Notice:
This version of ELM requires the use of a
elm directory in yoru home
directory to store your elmrc and alias files.
Shall I create the
directory .elm for you and set it up (y/n)?
Yes.
Great! I'll do it now

Reading in /usr/spool/mail/*yourlogin*,
message:0
Mailbox is '/usr/spool/mail/*yourlogin*' with 0
messages [ELM 2.3 PL11]

4

Any incoming mail is listed up here.

You can use any of the following commands by pressing the first character,
d)elete or u)ndelete mail, m)ail a message,
r)eply of f)orward mail, q)uit
To read a message, press <return>.
j = move down, k = move up, ? = help

Command

tech profiles

ricardo uribe;

guiding our future

Entering the Advanced Digital Systems Laboratory (ADSL) means entering the future of engineering, a future encouraged by Professor Ricardo Uribe. Uribe considers himself a friend to students in ECE 246, 272, 296, 498 and 499 who learn about advanced digital devices that contain microcomputers and microprocessors.

These classes are in actuality free-form labs, where students are encouraged to pursue projects they enjoy. Uribe wants to "provide an environment that gives the students confidence...where they won't be policed." He feels that the students' potential for creativity is wasted if they are told what to do. After picking a project, students are provided with the materials and means to learn, but the students do not listen to lecturers and never take tests. For those a bit uncertain in their roaming, Uribe provides a syllabus with a framework of eleven possible areas; vehicle simulation, music, image and voice processing, graphics, robotics, networks, software, peripherals, open house projects or support projects of ECE 311, 249 and other courses.

The course meets on fridays for an hour to discuss projects, but other meeting times are worked out individually. Usually, a project will have a group of two to four people working on it, although some projects have more people involved. At the end of the semester a device must be designed, built, tested and documented. The project is then shown off at the ADSL open house at the end of the semester. Therefore students participate in all components of product development while improving their communication skills involved in the presentation of their design. Uribe feels that this process is closer to the actual "real world" design process than many classes ever come.

Uribe provides his students with new avenues to learning engineering which excites student potentials and stops learning from becoming a chore.

varied; diversified —SYN. see D
adv. —di·verse′ness n.
di·ver·si·fied (də vur′sə fīd′, dī-) a
di·ver·si·form (-fôrm′) adj. [see DI
various forms or shapes
di·ver·si·fy (-fī′) vt. -fied′, -fy′ing [
diversifier < ML. diversificare, t
diversus (see DIVERSE) + facere, D
give variety to; vary 2. to divid
bilities [illegible] different com
3. to expand (a business, line of pro
ing the variety of things produced
taken —vi. to undertake expansion
otherwise multiply business opera
tion n.
di·ver·sion (də vur′zhən, dī-) n. [
diversio (for LL. diversio)] 1. a div
(from) [diversion of funds from the
of attention [diversion of the ene
diverts or distracts the attention
amusement
di·ver·sion·ar·y (-er′ē) adj. having
sion; specif., Mil. serving to distra
main point of attack [diversionary
di·ver·sion·ist (-ist) n. a person e
activity or tactics
di·ver·si·ty (də vur′sə tē, dī-) n., p
OFr. diversité] 1. quality, state, fa
diverse; difference 2. variety
di·vert (-vurt′) vt. [ME. diverten
divertere: see DIVERSE] 1. to turn (
(from a course, direction, etc.); de
attention of 3. to amuse; entertai
di·ver·tic·u·li·tis (dī′vər tik′yoo
inflammation of a diverticulum
di·ver·tic·u·lo·sis (-lō′sis) n. [
condition of having a number of
from the wall of the intestinal trac
di·ver·tic·u·lum (dī′vər tik′yoo
diverticulum, var. of deverticulum, a
turn aside < de-, from + vertere, to
abnormal pouch or sac opening ou
or main cavity